NILS
NATIONAL INTEGRATED
LAND SYSTEM

Measurement Management Use Cases

July 2001

Bureau of Land Management

About this document

This document is the summary of the Measurement Management (MM) use cases for the National Integrated Land System (NILS) project. These use cases describe how to manage survey measurement data and other geometric data in an automated environment.

These use cases were written with the understanding that the current functionality of the Geographic Measurement Management (GMM) application software will be built into the new Measurement Management application. Having an understanding of GMM and surveying methods and terminology will aid in reviewing these use cases.

NILS – Measurement Management Use Case Team:

Al Kaiser – USFS, Milwaukee
David Grainger – CASO, Sacramento
Dennis McKay – AZSO, Phoenix
Don Chambers – ESRI, Redlands
Jerry Sullivan – WO330D, Denver
Mark Williams – ESRI, Redlands

Change History

Date	Primary Author	Description
2/5/2001	Mark Williams	Compilation of MM use cases
7/17/2001	Mark Williams	Edits to original use cases and the addition of MM 1.13
8/8/01	Mani, Jerry	Check/correct grammar, punctuation, etc.

Measurement Management Use Cases - Index

MM 1.01 Construct point and line features by direction and distance

High Level Description	
Purpose	Calculate coordinate values of a new point based on the direction and distance from an existing point(s) and connect new point(s) with line feature(s) where necessary. Attributes the new point with a point identifier and computation method.
Actors	System users
Precondition	There are no coordinates for a new point and no necessary line features connecting point features.
Postcondition	The new point has coordinates and necessary line features are computed.
Description	Coordinates are calculated for a new point and all necessary line features are created.
Cross reference	Uses: Extends:
Development Implications and Considerations	
Data considerations	
Requirements addressed	

Primary Scenario	
Actor Action	**System Response**
1. This use case begins when the user selects the "Direction and Distance" COGO procedure button on the COGO Procedure Parameter Form.	2. Present the COGO Procedure Parameter Form with the "Direction and Distance" field boxes enabled. Assist user in selecting features.
3. Select/Edit From Point and To Point; point identifiers, coordinates, direction and/or distance, by manual input or by selection of features from display. Select input, computation and display modes. Direction values can be Azimuth or Bearings and formats can be Radians, Grad, DDMMSS.s, DD.ddddd, DDMM.mmm, etc. Distance units can be meters, international meters, international feet, U.S. Survey feet, Chains, etc. Elevation units can be feet or meters. Type of input for coordinates depends on Datum type selected. Computation Mode depends on type selected, geodetic or plane. Type of display for New Point coordinates depends on Datum Display mode selected. Examples of selection from display for direction and/or distance are: Select a to point to determine direction and/or distance. Select a line for parallel to line to determine direction. Select two lines to determine a weighted mean	4. Updates appropriate *COGO procedure parameter form* fields with values of selected features as each feature is selected, and highlights the selected features on the graphic display. Manual input of existing feature's point identifiers or coordinates selects and highlights that feature. Steps through each input field as form is filled out, starting with initial From Point. Features can be selected from graphics display when an input field is the focus. Selecting line(s) fills in From point and To point fields when the focus is the From point field. Computes and graphically displays highlighted new line feature(s) between From Point and To Point. System generates a point ID that is based on sequential or other rules as a default value for the new point. When all necessary parameters are filled in, the computations are performed and an answer is displayed in the *COGO procedure parameter form's* New Point field. As changes are made in parameters the system computes and displays new values in the New Point field. Update graphic display, including notification and symbolization of pre-existing points or IDs within distance tolerance.

direction. Select a backsight point or line for horizontal angle input to determine direction. Select a line of the same length as the desired distance. Select two points to determine the desired distance. Select any new position from display for a to point. Defaults are the last selected values and modes.	Prompt to save resulting coordinates and/or computations. [parameters are incorrect] Go to 3 [parameters correct] Go to 5
5. User selects appropriate action button. Note *COGO Procedure Parameter Form* stays available for further computations until [Save] or [Close] button is selected.	6. Process according to input from actor. **[Delete]** Deletes the current computations and parameters and opens the next logical *COGO Procedure Parameter Form* for editing. **[Back]** Go to the *COGO Procedure Parameter Form* for last computation. Back does not save current *COGO Procedure Parameter Form's* parameters and computations, but keeps them in memory. **[Next]** default; same as save except, goes to step 5 and leaves *COGO Procedure Parameter Form* available for editing**.** Also acts as [Forward] selection, to step forward through *COGO Procedure Parameter Forms*. **[Save]** save coordinates with appropriate point ID (may be new or replacement of existing) and save new line features, also save *computations* (to support audit; retrievable for layout, reconstruction and then closes the *COGO Procedure Parameter Form*. **[Cancel]** Exits without saving changes and closes the *COGO Procedure Parameter Form*.

Secondary Scenario	
Actor Action	**System Response**
Surveyor needs to establish a *field survey* before performing calculations.	Step 1 or 2. Use ***SM-02 Pre-Field Survey Setup*** or ***SM-03 In-Field Survey Setup*** to retrieve/apply *field survey setup file* and retrieve/setup *measurement data set* and reference data set.
Surveyor needs to establish an *observation set* to select input features or save output features.	Step 4. Use ***SM-04 Collect Field Survey Data In Real Time***and retrieve/setup *observation set*.
Actor needs to reconstruct a feature or duplicate a procedure from existing *COGO procedures.*	Step 1. Assist actor to find and retrieve feature and/or *COGO procedure*.
New point violates *Point-ID duplication protection.*	Step 3. [point ID already exists] retrieve *computation* for existing *point*, displays both the existing points and the new point's *COGO procedure parameter forms*. Actor modifies as needed.
New point violates *procedure duplication protection.*	Step 3. [a *point* has previously been calculated with an equivalent *computation*] prompt actor to accept existing point's procedures or rename ID. Cannot

	save procedures unless procedures or ID is changed.
Locate a point in the Area of Interest and center on display, inputs a New Point into the point ID or coordinates field and selects Find button.	Centers display on selected point at the same scale as display is at when selection is made, highlights the selected point and updates the *COGO procedure parameter form's* initial From Point field's with the values from the point selected if applicable. [selected point is a measured point]Centers display on selected point at the same scale as display is at when selection is made, opens the *Record Survey Data Spreadsheet* and highlights the selected point, both on the display and in the spreadsheet. See the MM use case, "3.06. Display/Edit Record line data in spreadsheet format"
New point is computed on line between existing points.	Step 4. [geodetic mode]moves point to geodetic line and computes new line features.

Direction Distance COGO Parameter Form

COGO Method: (•) Dir./Dist. ( ) Intersect ( ) Proportion ( ) Offset ( ) Average ( ) Add a Line ( ) Aliquot COGO wizard [ ] Multiple Selection Editor

---

Section Subdivision: [√] Subdivide by rules. **Level of automatic subdivision:** [10 ac – 1/64 cors] ↓ **Selection Buffer Level:** [10 ac – 1/64 cors] ↓

From Point: [*Point Identifier*] [*x, y, z*] **Datum Mode:** [Projection] ↓ **Computation mode**: (•) Geodetic ( )Plane

Direction: [*Direction Reference*] ↓ [*Direction value*] **Format:** [DDMMSS.s] ↓ **Elevation Units:** [feet] ↓

Feature Reference: [To Point *[*Point ID*] [*x, y, z*] **]** ↓
Parallel to line *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*]
Weighted mean bearing *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*] and *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*]
Horiz. angle from Backsight *[*Point ID*] [*x, y, z*]. Turn angle clockwise: [*angle value*]

Distance: [*Distance value*] **Unit:** [Survey Feet] ↓ **Type:** [Sea Level] ↓ **Offset to:** [Right/Left]↓

Feature Reference: [Pick Line *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*] **]** ↓
Pick two points *[Point ID] [*x, y, z*] to *[Point ID] [*x, y, z*]

From Point: [*Point Identifier*] [*x, y, z*] **Datum Mode:** [Projection] ↓ **Computation mode**: ( ) Geodetic (•)Plane

Direction: [*Direction Reference*] ↓ [*Direction value*] **Format:** [DDMMSS.s] ↓ **Elevation Units:** [feet] ↓

Feature Reference: [To Point *[*Point ID*] [*x, y, z*] **]** ↓
Parallel to line *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*]
Weighted mean bearing *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*] and *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*]
Horiz. angle from Backsight *[*Point ID*] [*x, y, z*]. Turn angle clockwise: [*angle value*]

Distance: [*Distance value*] **Unit:** [Survey Feet] ↓ **Type:** [Sea Level] ↓ **Offset to:** [Right/Left]↓

Feature Reference: [Pick Line *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*] **]** ↓
Pick two points *[Point ID] [*x, y, z*] to *[Point ID] [*x, y, z*]

Proportion: [*Proportion value*]
(•) Midpoint
( ) Inverse-divided-by-Record of selected feature
( )Ratio of Total Distance

Points within tolerance :**[** List of *Point IDs, x, y, z; Δx,Δy,Δz; weights;* [√ avg] **]** ↓ **Tolerance:** [*value*]

New Point: [*Point ID*] [*x, y, z*] **Datum Display Mode:** [*Projection*] ↓ [√] Point created by extension-type intersection **[Find]**

[Delete] [Back] [Next] [Save] [Cancel]

MM 1.02 Construct point and line features by proportion

High Level Description	
Purpose	Calculate coordinate values of a new point based on the direction and a proportionate (record measurement versus new measurement) distance along a line from a point and connect new point with line feature(s) where necessary. Attributes the new point with a point identifier and computation method.
Actors	System users
Precondition	There are no coordinates for a new point and no necessary line features connecting point features.
Postcondition	The new point has coordinates and necessary line features are computed.
Description	Coordinates are calculated for a new point and all necessary line features are created.
Cross reference	Uses: Extends:
Development Implications and Considerations	
Data considerations	There may be the need for the record data to exist in order to do the proportion.
Requirements addressed	

Primary Scenario	
Actor Action	**System Response**
1. This use case begins when the user selects the "Proportion" COGO procedure button on the COGO Procedure Parameter Form.	2. Present the COGO Procedure Parameter Form with the "Proportion" field boxes enabled. Assist user in selecting features.
3. Select/Edit From Point and To Point; point identifiers, coordinates, direction and/or distance, by manual input or by selection of features from display. Select input, computation and display modes. Select Proportion mode to apply proportion computations to 2nd distance (record proportion distance). If number of segments is filled in, the divide line into equal segments mode is selected. Manual entry of proportion values can be arithmetic. Direction values can be Azimuth or Bearings and formats can be Radians, Grad, DDMMSS.s, DD.ddddd, DDMM.mmm, etc. Distance units can be meters, international meters, international feet, U.S. Survey feet, Chains, etc. Elevation units can be feet or meters. Type of input for coordinates depends on Datum mode selected. Computation Mode depends on type selected, geodetic or plane.	4. Updates appropriate *COGO procedure parameter form* fields with values of selected features as each feature is selected, and highlights the selected features on the graphic display. Manual input of an existing feature's point ID or coordinates selects and highlights that feature. Steps through each input field as form is filled out, starting with initial From Point. Features can be selected from graphics display when an input field is the focus. Selecting line(s) fills in From point and To point fields when the focus is the From point field. Computes and graphically displays highlighted new line feature(s). System generates a point ID that is based on sequential or other rules as a default value for the new point. When all necessary parameters are filled in, the computations are performed and an answer is displayed in the *COGO procedure parameter form's* New Point field. As changes are made in parameters the system computes and displays new values in the New Point field. Computed proportion distance is displayed in the initial Distance field.

geodetic or plane. Type of display for New Point coordinates depends on Datum Display mode selected. Examples of selection from display for protraction are: Select a From point and To point to determine inverse and record distance. Select a line or line segments to determine inverse and record distance. Note: Selecting line(s) fills in From point and To point fields when the focus is the From point field. Select a line of the same length as the desired proportion distance. Select two points to determine the desired proportion distance. Defaults are the last selected values and modes.	Update graphic display, including notification and symbolization of pre-existing points or IDs within distance tolerance. Prompt to save resulting coordinates and/or computations. [parameters are incorrect] Go to 3 [parameters correct] Go to 5
5. User selects appropriate action button. Note *COGO Procedure Parameter Form* stays available for further computations until [Save] or [Close] button is selected.	6. Process according to input from actor. **[Delete]** Deletes the current computations and parameters and opens the next logical *COGO Procedure Parameter Form* for editing. **[Back]** Go to the *COGO Procedure Parameter Form* for last computation. Back does not save current *COGO Procedure Parameter Form's* parameters and computations, but keeps them in memory. **[Next]** default; same as save except, goes to step 5 and leaves *COGO Procedure Parameter Form* available for editing**.** Also acts as [Forward] selection, to step forward through *COGO Procedure Parameter Forms*. **[Save]** save coordinates with appropriate point ID (may be new or replacement of existing) and save new line features, also save *computations* (to support audit; retrievable for layout, reconstruction and then closes the *COGO Procedure Parameter Form*. **[Cancel]** Exits without saving changes and closes the *COGO Procedure Parameter Form*.

Secondary Scenario	
Actor Action	**System Response**
Surveyor needs to establish a *field survey* before performing calculations.	Step 1 or 2. Use ***SM-02 Pre-Field Survey Setup*** or ***SM-03 In-Field Survey Setup*** to retrieve/apply *field survey setup file* and retrieve/setup *measurement data set* and reference data set.
Surveyor needs to establish an *observation set* to select input features or save output features.	Step 4. Use ***SM-04 Collect Field Survey Data In Real Time***and retrieve/setup *observation set*.
Actor needs to reconstruct a feature or duplicate a procedure from existing *COGO procedures.*	Step 1. Assist actor to find and retrieve feature and/or *COGO procedure*.
New point violates *Point-ID duplication protection.*	Step 3. [point ID already exists] retrieve *computation* for existing *point*, displays both the existing points and

protection.	the new point's *COGO procedure parameter forms*. Actor modifies as needed.
New point violates *procedure duplication protection.*	Step 3. [a *point* has previously been calculated with an equivalent *computation*] prompt actor to accept existing point's procedures or rename ID. Cannot save procedures unless procedures or ID is changed.
Locate a point in the Area of Interest and center on display, inputs a New Point into the point ID or coordinates field and selects Find button.	Centers display on selected point at the same scale as display is at when selection is made, highlights the selected point and updates the *COGO procedure parameter form's* initial From Point field's with the values from the point selected if applicable. [selected point is a measured point]Centers display on selected point at the same scale as display is at when selection is made, opens the *Record Survey Data Spreadsheet* and highlights the selected point, both on the display and in the spreadsheet. See the MM use case, "3.06. Display/Edit Record line data in spreadsheet format"
New point is computed on line between existing points.	Step 4. [geodetic mode]moves point to geodetic line and computes new line features.

Proportion COGO Parameter Form

COGO Method: ( ) Dir./Dist. ( ) Intersect (•) Proportion ( ) Offset ( ) Average ( ) Add a Line ( ) Aliquot COGO wizard [ ] Multiple Selection Editor

---

Section Subdivision: [√] Subdivide by rules. **Level of automatic subdivision:** [10 ac – 1/64 cors] ↓ **Selection Buffer Level:** [10 ac – 1/64 cors] ↓

From Point: [*Point Identifier*] [*x, y, z*] **Datum Mode:** [Projection] ↓ **Computation mode**: ( ) Geodetic (•)Plane

Direction: [*Direction Reference*] ↓ [*Direction value*] **Format:** [DDMMSS.s] ↓ **Elevation Units:** [feet] ↓

Feature Reference: [To Point *[*Point ID*] [*x, y, z*] **]** ↓
Parallel to line *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*]
Weighted mean bearing *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*] and *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*]
Horiz. angle from Backsight *[*Point ID*] [*x, y, z*]. Turn angle clockwise: [*angle value*]

Distance: [*Distance value*] **Unit:** [Survey Feet] ↓ **Type:** [Sea Level] ↓ **Offset to:** [Right/Left]↓

Feature Reference: [Pick Line *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*] **]** ↓
Pick two points *[Point ID] [*x, y, z*] to *[Point ID] [*x, y, z*]

From Point: [*Point Identifier*] [*x, y, z*] **Datum Mode:** [Projection] ↓ **Computation mode**: ( ) Geodetic (•)Plane

Direction: [*Direction Reference*] ↓ [*Direction value*] **Format:** [DDMMSS.s] ↓ **Elevation Units:** [feet] ↓

Feature Reference: [To Point *[*Point ID*] [*x, y, z*] **]** ↓
Parallel to line *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*]
Weighted mean bearing *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*] and *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*]
Horiz. angle from Backsight *[*Point ID*] [*x, y, z*]. Turn angle clockwise: [*angle value*]

Distance: [*Distance value*] **Unit:** [Survey Feet] ↓ **Type:** [Sea Level] ↓ **Offset to:** [Right/Left]↓

Feature Reference: [Pick Line *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*] **]** ↓
Pick two points *[Point ID] [*x, y, z*] to *[Point ID] [*x, y, z*]

Proportion: [*Proportion value*]
(•) Midpoint
( ) Inverse-divided-by-Record of selected feature
( )Ratio of Total Distance

Points within tolerance :**[** List of *Point IDs, x, y, z; Δx,Δy,Δz;weigthts;* [√ avg] **]** ↓ **Tolerance:** [*value*]
New Point: [*Point ID*] [*x, y, z*] **Datum Display Mode:** [*Projection*] ↓ [√] Point created by extension-type intersection **[Find]**

[Delete] [Back] [Next] [Save] [Cancel]

MM 1.03 Construct point and line features by intersection

High Level Description	
Purpose	Calculate coordinate values of a new point based on the intersection of two lines and connect new point with line feature(s) where necessary. Attributes the new point with a point identifier and computation method.
Actors	System users
Precondition	There are no coordinates for a new point and no necessary line features connecting point features.
Postcondition	The new point has coordinates and necessary line features are computed.
Description	Coordinates are calculated for a new point and all necessary line features are created.
Cross reference	Uses: Extends:
Development Implications and Considerations	
Data considerations	
Requirements addressed	

Primary Scenario	
Actor Action	**System Response**
1. This use case begins when the user selects the "Intersection" COGO procedure button on the COGO Procedure Parameter Form.	2. Present the COGO Procedure Parameter Form with the "Intersection" field boxes enabled. Assist user in selecting features.
3. Select/Edit From Point and To Point; point identifiers, coordinates, direction and/or distance, by manual input or by selection of features from display. Select input, computation and display modes. Direction values can be Azimuth or Bearings and formats can be Radians, Grad, DDMMSS.s, DD.ddddd, DDMM.mmm, etc. Distance units can be meters, international meters, international feet, U.S. Survey feet, Chains, etc. Elevation units can be feet or meters. Input projection is selected. Type of input for coordinates depends on Datum mode selected. Computation Mode depends on type selected, geodetic or plane. Type of display for New Point coordinates depends on Datum Display mode selected. Examples of selection from display for intersection are: Select From Points and To Points to determine inverse lines to intersect. Select line or line segments to determine inverse and intermediate segment to intersect.	4. Updates appropriate *COGO procedure parameter form* fields with values of selected features as each feature is selected, and highlights the selected features on the graphic display. Manual input of an existing feature's point ID or coordinates selects and highlights that feature. Steps through each input field as form is filled out, starting with initial From Point. Features can be selected from graphics display when an input field is the focus. Selecting line(s) fills in From point and To point fields when the focus is the From point field. Computes and graphically displays highlighted new line feature(s). System generates a point ID that is based on sequential or other rules as a default value for the new point. When all necessary parameters are filled in, the computations are performed and an answer is displayed in the *COGO procedure parameter form's* New Point field. As changes are made in parameters the system computes and displays new values in the New Point field. Update graphic display, including notification and symbolization of pre-existing points or IDs within distance tolerance.

Note: Selecting line(s) fills in From point and To point fields when the focus is the From point field. Select a to point to determine direction and/or distance. Select a line for parallel to line to determine direction. Select two lines to determine a weighted mean direction. Select a backsight point or line for horizontal angle input to determine direction. Select a line of the same length as the desired distance. Select two points to determine the desired distance. Defaults are the last selected values and modes.	Prompt to save resulting coordinates and/or computations. [parameters are incorrect] Go to 3 [parameters correct] Go to 5
5. User selects appropriate action button. Note *COGO Procedure Parameter Form* stays available for further computations until [Save] or [CANCEL] button is selected.	8. Process according to input from actor. **[Delete]** Deletes the current computations and parameters and opens the next logical *COGO Procedure Parameter Form* for editing. **[Back]** Go to the *COGO Procedure Parameter Form* for last computation. Back does not save current *COGO Procedure Parameter Form's* parameters and computations, but keeps them in memory. **[Next]** default; same as save except, goes to step 5 and leaves *COGO Procedure Parameter Form* available for editing**.** Also acts as [Forward] selection, to step forward through *COGO Procedure Parameter Forms*. **[Save]** save coordinates with appropriate point ID (may be new or replacement of existing) and save new line features, also save *computations* (to support audit; retrievable for layout, reconstruction and then closes the *COGO Procedure Parameter Form*. **[Cancel]** Exits without saving changes and closes the *COGO Procedure Parameter Form*.

Secondary Scenario	
Actor Action	**System Response**
Surveyor needs to establish a *field survey* before performing calculations. (Rev. 2)	Step 1 or 2. Use ***SM-2.01 Field Survey Setup*** to retrieve/apply *field survey setup file* and retrieve/setup *measurement data set* and reference data set.
Surveyor needs to establish an *observation set* to select input features or save output features. (Rev. 2)	Step 4. Use ***SM-4.01 Collect Field Survey Data In Real Time*** and retrieve/setup *observation set*.
Actor needs to reconstruct a feature or duplicate a procedure from existing *COGO procedures.*	Step 1. Assist actor to find and retrieve feature and/or *COGO procedure*.
New point violates *Point-ID duplication protection.*	Step 3. [point ID already exists] retrieve *computation* for existing *point*, displays both the existing points and the new point's *COGO procedure parameter forms*.

	Actor modifies as needed.
New point violates *procedure duplication protection.*	Step 3. [a *point* has previously been calculated with an equivalent *computation*] prompt actor to accept existing point's procedures or rename ID. Cannot save procedures unless procedures or ID is changed.
Locate a point in the Area of Interest and center on display, inputs a New Point into the point ID or coordinates field and selects Find button.	Centers display on selected point at the same scale as display is at when selection is made, highlights the selected point and updates the *COGO procedure parameter form's* initial From Point field's with the values from the point selected if applicable. [selected point is a measured point]Centers display on selected point at the same scale as display is at when selection is made, opens the *Record Survey Data Spreadsheet* and highlights the selected point, both on the display and in the spreadsheet. See the MM use case, "3.06. Display/Edit Record line data in spreadsheet format"
New point is computed on line between existing points.	Step 4. [geodetic mode] moves point to geodetic line and computes new line features.

Intersection COGO Parameter Form

COGO Method: ( ) Dir./Dist. (•) Intersect ( ) Proportion ( ) Offset ( ) Average ( ) Add a Line ( ) Aliquot COGO wizard [ ] Multiple Selection Editor

---

Section Subdivision: [√] Subdivide by rules. **Level of automatic subdivision:** [10 ac – 1/64 cors] ↓ **Selection Buffer Level:** [10 ac – 1/64 cors] ↓

From Point: [*Point Identifier*] [*x, y, z*] **Datum Mode:** [Projection] ↓ **Computation mode**: ( ) Geodetic (•)Plane

Direction: [*Direction Reference*] ↓ [*Direction value*] **Format:** [DDMMSS.s] ↓ **Elevation Units:** [feet] ↓

Feature Reference: [To Point *[*Point ID*] [*x, y, z*] **]** ↓
Parallel to line *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*]
Weighted mean bearing *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*] and *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*]
Horiz. angle from Backsight *[*Point ID*] [*x, y, z*]. Turn angle clockwise: [*angle value*]

Distance: [*Distance value*] **Unit:** [Survey Feet] ↓ **Type:** [Sea Level] ↓ **Offset to:** [Right/Left]↓

Feature Reference: [Pick Line *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*] **]** ↓
Pick two points *[Point ID] [*x, y, z*] to *[Point ID] [*x, y, z*]

From Point: [*Point Identifier*] [*x, y, z*] **Datum Mode:** [Projection] ↓ **Computation mode**: ( ) Geodetic (•)Plane

Direction: [*Direction Reference*] ↓ [*Direction value*] **Format:** [DDMMSS.s] ↓ **Elevation Units:** [feet] ↓

Feature Reference: [To Point *[*Point ID*] [*x, y, z*] **]** ↓
Parallel to line *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*]
Weighted mean bearing *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*] and *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*]
Horiz. angle from Backsight *[*Point ID*] [*x, y, z*]. Turn angle clockwise: [*angle value*]

Distance: [*Distance value*] **Unit:** [Survey Feet] ↓ **Type:** [Sea Level] ↓ **Offset to:** [Right/Left]↓

Feature Reference: [Pick Line *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*] **]** ↓
Pick two points *[Point ID] [*x, y, z*] to *[Point ID] [*x, y, z*]

Proportion: [*Proportion value*]
(•) Midpoint
( ) Inverse-divided-by-Record of selected feature
( )Ratio of Total Distance

Points within tolerance :**[** List of *Point IDs, x, y, z; Δx,Δy,Δz;weigthts;* [√ avg] **]** ↓ **Tolerance:** [*value*]

New Point: [*Point ID*] [*x, y, z*] **Datum Display Mode:** [*Projection*] ↓ [√] Point created by extension-type intersection **[Find]**

[Delete] [Back] [Next] [Save] [Cancel]

MM 1.04 Construct point and line features by offset from a straight line

High Level Description	
Purpose	Calculate coordinate values of new point(s) based on a fixed distance from an existing line feature(s) and connect new point(s) with line feature(s) where necessary. Attributes the new point(s) with a point identifier and computation method.
Actors	System users
Precondition	There are no coordinates for a new point and no necessary line features connecting point features.
Postcondition	The new point(s) has coordinates and necessary line features are computed.
Description	Coordinates are calculated for new point(s) and all necessary line features are created.
Cross reference	Uses: Extends:
Development Implications and Considerations	
Data considerations	
Requirements addressed	

Primary Scenario	
Actor Action	**System Response**
1. This use case begins when the user selects the "Offset" COGO procedure button on the COGO Procedure Parameter Form.	2. Present the COGO Procedure Parameter Form with the "Offset" field boxes enabled. Assist user in selecting features.
3. Select/Edit From Point and To Point; point identifiers, coordinates, direction and/or distance, by manual input or by selection of features from display. Select input, computation and display modes. Select a baseline to compute a perpendicular offset from. Select a distance to define the offset point's distance. Select Right or Left side of baseline as defined by the From and To points. Select a line to define the direction of the 1st bounding line. Direction values can be Azimuth or Bearings and formats can be Radians, Grad, DDMMSS.s, DD.ddddd, DDMM.mmm, etc. Distance units can be meters, international meters, international feet, U.S. Survey feet, Chains, etc. Elevation units can be feet or meters. Type of input for coordinates depends on Datum mode selected. Computation Mode depends on type selected, geodetic or plane. Type of display for New Point coordinates depends on Datum Display mode selected.	4. Updates appropriate *COGO procedure parameter form* fields with values of selected features as each feature is selected, and highlights the selected features on the graphic display. Manual input of an existing feature's point ID's or coordinates selects and highlights that feature. Steps through each input field as form is filled out, starting with initial From Point. Features can be selected from graphics display when an input field is the focus. Selecting line(s) fills in From point and To point fields when the focus is the From point field. System generates a point ID that is based on sequential or other rules as a default value for the new point. When all the baseline, offset distance and a bounding line's parameter fields are filled in, computes the offset point, computes the intersection with an offset line through the computed offset point and the bounding line. Results of the computations for the intersection point are displayed in the *COGO procedure parameter form's* New Point field. As changes are made in parameters the system computes and displays new values in the New Point field. Update graphic display, including notification and

Examples of selection from display for offset are: Select From Points and To Points to determine direction of line to offset from. Select line or line segments to determine direction of line to offset from. Note: Selecting line(s) fills in From point and To point fields when the focus is the From point field. Select a to point to determine direction of line to offset from. Select a line for parallel to line to determine direction of line to offset from. Select two lines to determine a weighted mean direction of line to offset from. Select a backsight point or line for horizontal angle input to determine direction of line to offset from. Select a line of the same length as the desired distance to offset point. Select two points to determine the desired distance to offset point. Defaults are the last selected values and modes.	symbolization of pre-existing points or IDs within distance tolerance. [parameters are incorrect] Go to 3 [parameters correct] Present *COGO procedure parameter form* for the final bounding line input, Go to 5.
5. Select a line to define the direction of final bounding line.	6. Computes the intersection of the final bounding line with the offset line computed in step 4. When all necessary parameters are filled in, the computations are performed and results of the computations for the final intersection point are displayed in the *COGO procedure parameter form's* New Point field. As changes are made in parameters the system computes and displays new values in the New Point field. Computes a new line feature between the two intersection points. Graphically displays highlighted new line feature(s). Update graphic display, including notification and symbolization of pre-existing points or IDs within distance tolerance. Prompt to save resulting coordinates and/or computations. [parameters of initial *COGO procedure parameter form* are incorrect] Reopen the initial *COGO procedure parameter form* and go to 3. [parameters of final *COGO procedure parameter form* are incorrect] Go to 5 [parameters correct] Go to 7

7. User selects appropriate action button. Note *COGO Procedure Parameter Form* stays available for further computations until [Save] or [Close] button is selected.	8. Process according to input from actor. **[Delete]** Deletes the current computations and parameters and opens the next logical *COGO Procedure Parameter Form* for editing. **[Back]** Go to the *COGO Procedure Parameter Form* for last computation. Back does not save current *COGO Procedure Parameter Form's* parameters and computations, but keeps them in memory. **[Next]** default; same as save except, goes to step 5 and leaves *COGO Procedure Parameter Form* available for editing**.** Also acts as [Forward] selection, to step forward through *COGO Procedure Parameter Forms*. **[Save]** save coordinates with appropriate point ID (may be new or replacement of existing) and save new line features, also save *computations* (to support audit; retrievable for layout, reconstruction and then closes the *COGO Procedure Parameter Form*. **[Cancel]** Exits without saving changes and closes the *COGO Procedure Parameter Form*.

Secondary Scenario	
Actor Action	**System Response**
Surveyor needs to establish a *field survey* before performing calculations.	Step 1 or 2. Use ***SM-02 Pre-Field Survey Setup*** or ***SM-03 In-Field Survey Setup*** to retrieve/apply *field survey setup file* and retrieve/setup *measurement data set* and reference data set.
Surveyor needs to establish an *observation set* to select input features or save output features.	Step 4. Use ***SM-04 Collect Field Survey Data In Real Time***and retrieve/setup *observation set*.
Actor needs to reconstruct a feature or duplicate a procedure from existing *COGO procedures.*	Step 1. Assist actor to find and retrieve feature and/or *COGO procedure*.
New point violates *Point-ID duplication protection.*	Step 3. [point ID already exists] retrieve *computation* for existing *point*, displays both the existing point's and the new point's *COGO procedure parameter form*. Actor modifies as needed.
New point violates *procedure duplication protection.*	Step 3. [a *point* has previously been calculated with an equivalent *computation*] prompt actor to accept existing point's procedures or rename ID. Cannot save procedures unless procedures or ID is changed.
Locate a point in the Area of Interest and center on display, inputs a New Point into the point ID or coordinates field and selects Find button.	Centers display on selected point at the same scale as display is at when selection is made, highlights the selected point and updates the *COGO procedure parameter form's* initial From Point field's with the values from the point selected if applicable. [selected point is a measured point]Centers display on selected point at the same scale as display is at when selection is made, opens the *Record Survey Data Spreadsheet* and highlights the selected point, both on the display and in the spreadsheet. See the MM use case, "3.06. Display/Edit Record line

	data in spreadsheet format"
New point is computed on line between existing points.	Step 4. [geodetic mode]moves point to geodetic line and computes new line features.
Selection of a series of line segments to offset from (baselines).	Computes appropriate features and displays only the last computed feature's parameters on the *COGO procedure parameter form.* This allows for user to step BACK through all the *COGO procedure parameter forms* for all the features that were computed.

Offset COGO Parameter Form

COGO Method: ( ) Dir./Dist. ( ) Intersect ( ) Proportion (•) Offset ( ) Average ( ) Add a Line ( ) Aliquot COGO wizard [ ] Multiple Selection Editor

---

Section Subdivision: [√] Subdivide by rules. **Level of automatic subdivision:** [10 ac – 1/64 cors] ↓ **Selection Buffer Level:** [10 ac – 1/64 cors] ↓

From Point: [*Point Identifier*] [*x, y, z*] **Datum Mode:** [Projection] ↓ **Computation mode**: ( ) Geodetic (•)Plane

Direction: [*Direction Reference*] ↓ [*Direction value*] **Format:** [DDMMSS.s] ↓ **Elevation Units:** [feet] ↓

Feature Reference: [To Point *[*Point ID*] [*x, y, z*] **] ↓**
Parallel to line *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*]
Weighted mean bearing *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*] and *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*]
Horiz. angle from Backsight *[*Point ID*] [*x, y, z*]. Turn angle clockwise: [*angle value*]

Distance: [*Distance value*] **Unit:** [Survey Feet] ↓ **Type:** [Sea Level] ↓ **Offset to:** [Right/Left]↓

Feature Reference: [Pick Line *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*] **] ↓**
Pick two points *[Point ID] [*x, y, z*] to *[Point ID] [*x, y, z*]

From Point: [*Point Identifier*] [*x, y, z*] **Datum Mode:** [Projection] ↓ **Computation mode**: ( ) Geodetic (•)Plane

Direction: [*Direction Reference*] ↓ [*Direction value*] **Format:** [DDMMSS.s] ↓ **Elevation Units:** [feet] ↓

Feature Reference: [To Point *[*Point ID*] [*x, y, z*] **] ↓**
Parallel to line *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y,*
Weighted mean bearing *[*Point*] [*x, y, z*] to *[*Point ID*] [*x, y, z*] and *[*Point ID*, *y, z*] to *[*Point ID*] [*x, y, z*]
Horiz. angle from Backsight *[*Point ID*] [*x, y, z*]. Turn angle clockwise: [*angle value*]

Distance: [*Distance value*] **Unit:** [Survey Feet] ↓ **Type:** [Sea Level] ↓ **Offset to:** [Right/Left]↓

Feature Reference: [Pick Line *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*] **] ↓**
Pick two points *[Point ID] [*x, y, z*] to *[Point ID] [*x, y, z*]

Proportion: [*Proportion value*]
(•) Midpoint
( ) Inverse-divided-by-Record of selected feature
( )Ratio of Total Distance

Points within tolerance :**[** List of *Point IDs, x, y, z; Δx,Δy,Δz;weigthts;* [√ avg] **] ↓** **Tolerance:** [*value*]

New Point: [*Point ID*] [*x, y, z*] **Datum Display Mode:** [*Projection*] ↓ [√] Point created by extension-type intersection **[Find]**

[Delete] [Back] [Next] [Save] [Cancel]

MM 1.05 Compute Weighted Average of Coordinates

High Level Description	
Purpose	To compute average of coordinates of selected points based on weighting.
Actors	System users
Precondition	Multiple points exist within a given tolerance and need to average their coordinates.
Postcondition	The computed point has coordinates and point ID.
Description	Computes weighted average coordinates of selected points within a given tolerance.
Cross reference	Uses: Extends:
Development Implications and Considerations	Rules for subdivision
Data considerations	
Requirements addressed	

Primary Scenario	
Actor Action	**System Response**
1. This use case begins when the user selects the "Average" COGO procedure button on the COGO Procedure Parameter Form.	2. Present the COGO Procedure Parameter Form with the "Average" field boxes enabled. Prompt for tolerance and present a list of points to use in averaging computations.
3. Selects the Datum Display Mode to use. Inputs the tolerance value as a radial distance. Units for value are based on the Datum Display Mode selected. Can be feet, meters or geographic units. Marks the points to use in averaging computations on the list of Points within tolerance. The New Point values from the last computed point, using another COGO method, is marked in the list as default. Type of display for New Point coordinates depends on Datum Display mode selected.	4. Compute weighted average of selected points and updates the New Point field. Computes and graphically displays highlighted new line feature(s). System generates a point ID that is based on sequential or other rules as a default value for the new point. When all necessary parameters are filled in, the computations are performed and an answer is displayed in the *COGO procedure parameter form's* New Point field. As changes are made in parameters the system computes and displays new values in the New Point field. Update graphic display, including notification and symbolization of pre-existing points or IDs within distance tolerance. [parameters are incorrect] Go to 3 [parameters correct] Go to 5
5. User selects appropriate action button. Note *COGO Procedure Parameter Form* stays available for further computations until [Save] or [Close] button is selected.	6. Process according to input from actor. **[Back]** Go to the *COGO Procedure Parameter Form* for last computation. Back does not save current *COGO Procedure Parameter Form's* parameters and computations, but keeps them in memory. **[Next]** default; same as save except, goes to step 3

	and leaves *COGO Procedure Parameter Form* available for editing**.** Also acts as [Forward] selection, to step forward through *COGO Procedure Parameter Forms*. **[Save]** save coordinates with appropriate point ID (may be new or replacement of existing) and save new line features, also save *computations* (to support audit; retrievable for layout, reconstruction and then closes the *COGO Procedure Parameter Form*. **[Cancel]** Exits without saving changes and closes the *COGO Procedure Parameter Form*.

Secondary Scenario	
Actor Action	**System Response**
Surveyor needs to establish a *field survey* before performing calculations.	Step 1 or 2. Use ***SM-2.01 Field Survey Setup*** to retrieve/apply *field survey setup file* and retrieve/setup *measurement data set* and reference data set.
Surveyor needs to establish an *observation set* to select input features or save output features.	Step 4. Use ***SM-4.01 Collect Field Survey Data In Real Time*** and retrieve/setup *observation set*.
Actor needs to reconstruct a feature or duplicate a procedure from existing *COGO procedures.*	Step 1. Assist actor to find and retrieve feature and/or *COGO procedure*.
New point violates *Point-ID duplication protection.*	Step 3. [point ID already exists] retrieve *computation* for existing *point*, displays both the existing points and the new point's *COGO procedure parameter forms*. Actor modifies as needed.
New point violates *procedure duplication protection.*	Step 3. [a *point* has previously been calculated with an equivalent *computation*] prompt actor to accept existing point's procedures or rename ID. Cannot save procedures unless procedures or ID is changed.
Locate a point in the Area of Interest and center on display, inputs a New Point into the point ID or coordinates field and selects Find button.	Centers display on selected point at the same scale as display is at when selection is made, highlights the selected point and updates the *COGO procedure parameter form's* initial From Point field's with the values from the point selected if applicable. [selected point is a measured point]Centers display on selected point at the same scale as display is at when selection is made, opens the *Record Survey Data Spreadsheet* and highlights the selected point, both on the display and in the spreadsheet. See the MM use case, "3.06. Display/Edit Record line data in spreadsheet format"
New point is computed on line between existing points.	Step 4. [geodetic mode] moves point to geodetic line and computes new line features.

Average COGO Parameter Form

COGO Method: ( ) Dir./Dist. ( ) Intersect ( ) Proportion ( ) Offset (•) Average ( ) Add a Line ( ) Aliquot COGO wizard [ ] Multiple Selection Editor

---

Section Subdivision: [√] Subdivide by rules. **Level of automatic subdivision:** [10 ac – 1/64 cors] ↓ **Selection Buffer Level:** [10 ac – 1/64 cors] ↓

From Point: [*Point Identifier*] [*x, y, z*] **Datum Mode:** [Projection] ↓ **Computation mode**: ( ) Geodetic (•)Plane

Direction: [*Direction Reference*] ↓ [*Direction value*] **Format:** [DDMMSS.s] ↓ **Elevation Units:** [feet] ↓

Feature Reference: [To Point *[*Point ID*] [*x, y, z*] **]** ↓
Parallel to line *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*]
Weighted mean bearing *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*] and *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*]
Horiz. angle from Backsight *[*Point ID*] [*x, y, z*]. Turn angle clockwise: [*angle value*]

Distance: [*Distance value*] **Unit:** [Survey Feet] ↓ **Type:** [Sea Level] ↓ **Offset to:** [Right/Left]↓

Feature Reference: [Pick Line *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*] **]** ↓
Pick two points *[Point ID] [*x, y, z*] to *[Point ID] [*x, y, z*]

From Point: [*Point Identifier*] [*x, y, z*] **Datum Mode:** [Projection] ↓ **Computation mode**: ( ) Geodetic (•)Plane

Direction: [*Direction Reference*] ↓ [*Direction value*] **Format:** [DDMMSS.s] ↓ **Elevation Units:** [feet] ↓

Feature Reference: [To Point *[*Point ID*] [*x, y, z*] **]** ↓
Parallel to line *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*]
Weighted mean bearing *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*] and *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*]
Horiz. angle from Backsight *[*Point ID*] [*x, y, z*]. Turn angle clockwise: [*angle value*]

Distance: [*Distance value*] **Unit:** [Survey Feet] ↓ **Type:** [Sea Level] ↓ **Offset to:** [Right/Left]↓

Feature Reference: [Pick Line *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*] **]** ↓
Pick two points *[Point ID] [*x, y, z*] to *[Point ID] [*x, y, z*]

Proportion: [*Proportion value*]
(•) Midpoint
( ) Inverse-divided-by-Record of selected feature
( )Ratio of Total Distance

Points within tolerance :**[** List of *Point IDs, x, y, z; Δx,Δy,Δz;weigthts;* [√ avg] **]** ↓ **Tolerance:** [*value*]
New Point: [*Point ID*] [*x, y, z*] **Datum Display Mode:** [*Projection*] ↓ [√] Point created by extension-type intersection **[Find]**

[Delete] [Back] [Next] [Save] [Cancel]

MM 1.06 Construct line feature – circular curve

High Level Description	
Purpose	Construct a horizontal curve line feature based on input of curve parameters, either manually or by selection of existing features.
Actors	System users
Precondition	There are existing point and line features. Curved boundary line needs to be input into system.
Postcondition	Curve is calculated, displayed and added to data set.
Description	Creates a curved line feature (arc), based on parameters, for closure of a polygon.
Cross reference	Uses: Extends:
Development Implications and Considerations	
Data considerations	
Requirements addressed	

Primary Scenario	
Actor Action	**System Response**
1. This use case begins when the user selects the "Horizontal Curve" COGO procedure button on the COGO Procedure Parameter Form.	2. Present the Horizontal Curve COGO Procedure Parameter Form.
3. Select/Edit From Point and To Point of either the Long Chord or first Tangent and/or the radius; point identifiers, coordinates, direction and/or distance, by manual input or by selection of features from display. Input one of the following additional parameters if needed: Delta Angle (Δ), Degree of curve, Curve Definition (arc or chord), Arc Length, External, or Mid Ordinate. Select input, computation and display modes. Direction values can be Azimuth or Bearings and formats can be Radians, Grad, DDMMSS.s, DD.ddddd, DDMM.mmm, etc. Distance units can be meters, international meters, international feet, U.S. Survey feet, Chains, etc. Elevation units can be feet or meters. Type of input for coordinates depends on Datum mode selected. Computation Mode depends on type selected, geodetic or plane. Type of display for New Point coordinates depends on Datum Display mode selected. Examples of selection from display for direction and/or distance are: Select a to point to determine direction and/or distance.	4. Updates appropriate *COGO procedure parameter form* fields with values of selected features as each feature is selected, and highlights the selected features on the graphic display. Manual input of existing feature's point identifiers or coordinates selects and highlights that feature. Steps through each input field as form is filled out, starting with initial From Point. Features can be selected from graphics display when an input field is the focus. Selecting line(s) fills in From point and To point fields when the focus is the From point field. Computes and graphically displays highlighted new curve line feature(s) between From Point and To Point of Long Chord. System generates a point ID that is based on sequential or other rules as a default value for the new point. When all necessary parameters are filled in, the computations are performed and an answer is displayed in the *COGO procedure parameter form's* New Point field. As changes are made in parameters the system computes and displays new values in the New Point, Delta Angle (Δ), Degree of curve, Arc Length, External, Mid Ordinate fields. Update graphic display, including notification and symbolization of pre-existing points or IDs within distance tolerance.

Select a line for parallel to line to determine direction. Select two lines to determine a weighted mean direction. Select a backsight point or line for horizontal angle input to determine direction. Select a line of the same length as the desired distance. Select two points to determine the desired distance. Select any new position from display for a to point. Defaults are the last selected values and modes. User selects an existing curve as a means of populating the curve elements of a curve being constructed. This would bring the radius, length, etc. over as well as concavity, although the concavity would be overwritten if the tangent lines of the new curve indicate otherwise. This feature would benefit entering in fillets of a subdivision because fillets are generally a standard size. While populating the concavity field, user selects a point Right or Left of the long chord to indicate what side of the long chord the curve exists. Or if the curve is plotted with the wrong concavity, just drag the midpoint of the curve and drop it onto the other side of the long chord.	Prompt to save resulting coordinates and/or computations. [parameters are incorrect] Go to 3 [parameters correct] Go to 5
5. User selects appropriate action button. Note *COGO Procedure Parameter Form* stays available for further computations until [Save] or [Close] button is selected.	6. Process according to input from actor. **[Delete]** Deletes the current computations and parameters and opens the next logical *COGO Procedure Parameter Form* for editing. **[Back]** Go to the *COGO Procedure Parameter Form* for last computation. Back does not save current *COGO Procedure Parameter Form's* parameters and computations, but keeps them in memory. **[Next]** default; same as save except, goes to step 5 and leaves *COGO Procedure Parameter Form* available for editing**.** Also acts as [Forward] selection, to step forward through *COGO Procedure Parameter Forms*. **[Save]** save coordinates with appropriate point ID (may be new or replacement of existing) and save new line features, also save *computations* (to support audit; retrievable for layout, reconstruction and then closes the *COGO Procedure Parameter Form*. **[Cancel]** Exits without saving changes and closes the *COGO Procedure Parameter Form*.

Secondary Scenario	
Actor Action	**System Response**
Surveyor needs to establish a *field survey* before performing calculations.	Step 1 or 2. Use ***SM-2.01 Field Survey Setup*** to retrieve/apply *field survey setup file* and retrieve/setup *measurement data set* and reference data set.
Surveyor needs to establish an *observation set* to select input features or save output features.	Step 4. Use ***SM-4.01 Collect Field Survey Data In Real Time*** and retrieve/setup *observation set*.
Actor needs to reconstruct a feature or duplicate a procedure from existing *COGO procedures.*	Step 1. Assist actor to find and retrieve feature and/or *COGO procedure*.
New point violates *Point-ID duplication protection.*	Step 3. [point ID already exists] retrieve *computation* for existing *point*, displays both the existing points and the new point's *COGO procedure parameter forms*. Actor modifies as needed.
New point violates *procedure duplication protection.*	Step 3. [a *point* has previously been calculated with an equivalent *computation*] prompt actor to accept existing point's procedures or rename ID. Cannot save procedures unless procedures or ID is changed.
Locate a point in the Area of Interest and center on display, inputs a New Point into the point ID or coordinates field and selects Find button.	Centers display on selected point at the same scale as display is at when selection is made, highlights the selected point and updates the *COGO procedure parameter form's* initial From Point field's with the values from the point selected if applicable. [selected point is a measured point]Centers display on selected point at the same scale as display is at when selection is made, opens the *Record Survey Data Spreadsheet* and highlights the selected point, both on the display and in the spreadsheet. See the MM use case, "3.06. Display/Edit Record line data in spreadsheet format"
New point is computed on line between existing points.	Step 4. [geodetic mode] moves point to geodetic line and computes new line features.

Footnotes:

This footnote relates to use cases 1.8, 1.9, 1.10
1.8 – 1.10 Special curve situations.

Present day GMM does not show any curves, but allows a place to store simple and spiral curves. **We should at least have a prompting mechanism for this data and a place to store it.** If there is no place to store it, then how do we import curve data now from GCDB (3.01) if that curve data is spiral? See McKay's Core Data Elements ERD, but only with the caveat that another kind of curve exists. Rather, there are different ways in which to describe a spiral curve (See Oregon Department of Transportation literature) so the elements that are listed are not all relevant in those cases. Need new table or an expanded table.

CURVE PARAMETER FORM

Curve Type: ( ) Circular ( ) Spiral ( ) Offset to spiral centerline ( ) Medial line

---

CIRCULAR CURVE ORIENTATION:

From Point: [*Point Identifier*] [x, *y, z*] **Datum Mode:** [Projection] ↓

Chord Direction: [*Direction Reference*] ↓ [*Direction value*] **Format:** [DDMMSS.s] ↓

Feature Reference:	**Circular Curve Endpoint**	*[*Point ID*] [x, *y, z*]
Pick long chord		
Back Tangent line		to *[*Point ID*] [*x, y, z*]
Forward Tangent line		to *[*Point ID*] [*x, y, z*]

CIRCULAR CURVE DIMENSIONS:

Circular Long Chord Distance: [*Distance value*] **Unit:** [Survey Feet] ↓ **Type:** [Sea Level] ↓

Feature Reference:		
Pick long chord endpoints	*[*Point ID*] [x, *y, z*]	to *[*Point ID*] [x, *y, z*]
Pick chord endpoints	*[*Point ID*] [x, *y, z*]	to *[*Point ID*] [x, *y, z*]
Pick similar curve	*[*Point ID*] [x, *y, z*]	to *[*Point ID*] [x, *y, z*]

Arc Length: [*Distance value*] **Unit:** [Survey Feet] ↓ **Type:** [Sea Level] ↓

Feature Reference: Pick similar curve *[*Point ID]* [x, *y, z*] to *[*Point ID*] [x, *y, z*]

Radial Distance: [*Distance value*] **Unit:** [Survey Feet] ↓ **Type:** [Sea Level] ↓ **Concave to:** [Right]↓

Feature Reference: Pick similar curve *[*Point ID*] [x, *y, z*] to *[*Point ID*] [x, *y, z*]

Degree of Curvature: [*Angle value*] **Format:** [DDMMSS.s] ↓

Delta Angle: [*Angle value*] **Format:** [DDMMSS.s] ↓

Mid-Ordinate: [*Distance value*] **Unit:** [Survey Feet] ↓ **Type:** [Sea Level] ↓

External: [*Distance value*] **Unit:** [Survey Feet] ↓ **Type:** [Sea Level] ↓

MM 1.07 Construct line feature – straight or rhumb

High Level Description	
Purpose	To add a straight or rhumb line feature between existing point features for subdivision of polygons.
Actors	System users
Precondition	There are preexisting point features. There is no line feature subdividing a polygon between existing point features.
Postcondition	The line feature has been added between existing point features.
Description	Creates a line feature between selected point features for subdivision of a polygon.
Cross reference	Uses: Extends:
Development Implications and Considerations	
Data considerations	
Requirements addressed	

Primary Scenario	
Actor Action	**System Response**
1. This use case begins when the user selects the "Add a Line" COGO procedure button on the COGO Procedure Parameter Form.	2. Present the COGO Procedure Parameter Form with the "Add a Line" field boxes enabled. Assist user in selecting features.
3. Select/Edit From Point and To Point; point identifiers, or coordinates, by manual input or by selection of features from display. Select input, computation and display modes. Elevation units can be feet or meters. Type of input for coordinates depends on Datum mode selected. Computation Mode depends on type selected, geodetic or plane. Examples of selection from display for direction and/or distance are: Note: Selecting line(s) fills in From point and To point fields when the focus is the From point field. Select a to point to determine direction and distance. Select two points to determine direction and distance. Defaults are the last selected values and modes.	4. Updates appropriate *COGO procedure parameter form* fields with values of selected features as each feature is selected, and highlights the selected features on the graphic display. Manual input of existing feature's point identifiers or coordinates selects and highlights that feature. Steps through each input field as form is filled out, starting with initial From Point. Features can be selected from graphics display when an input field is the focus. Selecting line(s) fills in From point and To point fields when the focus is the From point field. Computes and graphically displays highlighted new line feature between From Point and To Point. When all necessary parameters are filled in, the computations are performed and an answer is displayed in the *COGO procedure parameter form's* initial direction and distance fields. The New Point fields are updated to the same values as the initial To Point's values. As changes are made in parameters the system computes and displays new values in the appropriate fields. Update graphic display, including notification and symbolization of pre-existing points or IDs within distance tolerance. Prompt to save resulting coordinates and/or computations. [parameters are incorrect] Go to 3

	[parameters correct] Go to 5
5. User selects appropriate action button. Note *COGO Procedure Parameter Form* stays available for further computations until [Save] or [Close] button is selected.	6. Process according to input from actor. **[Delete]** Deletes the current computations and parameters and opens the next logical *COGO Procedure Parameter Form* for editing. **[Back]** Go to the *COGO Procedure Parameter Form* for last computation. Back does not save current *COGO Procedure Parameter Form's* parameters and computations, but keeps them in memory. **[Next]** default; same as save except, goes to step 5 and leaves *COGO Procedure Parameter Form* available for editing**.** Also acts as [Forward] selection, to step forward through *COGO Procedure Parameter Forms*. **[Save]** save coordinates with appropriate point ID (may be new or replacement of existing) and save new line features, also save *computations* (to support audit; retrievable for layout, reconstruction and then closes the *COGO Procedure Parameter Form*. **[Cancel]** Exits without saving changes and closes the *COGO Procedure Parameter Form*.

Secondary Scenario	
Actor Action	**System Response**
Surveyor needs to establish a *field survey* before performing calculations.	Step 1 or 2. Use ***SM-2.01 Field Survey Setup*** to retrieve/apply *field survey setup file* and retrieve/setup *measurement data set* and reference data set.
Surveyor needs to establish an *observation set* to select input features or save output features.	Step 4. Use ***SM-4.01 Collect Field Survey Data In Real Time*** and retrieve/setup *observation set*.
Actor needs to reconstruct a feature or duplicate a procedure from existing *COGO procedures.*	Step 1. Assist actor to find and retrieve feature and/or *COGO procedure*.
New line violates *Point-ID duplication protection.*	Step 3. [point ID already exists] retrieve *computation* for existing *point*, displays both the existing points and the new point's *COGO procedure parameter forms*. Actor modifies as needed.
New point violates *procedure duplication protection.*	Step 3. [a *point* has previously been calculated with an equivalent *computation*] prompt actor to accept existing point's procedures or rename ID. Cannot save procedures unless procedures or ID is changed.
Locate a point in the Area of Interest and center on display, inputs a New Point into the point ID or coordinates field and selects Find button.	Centers display on selected point at the same scale as display is at when selection is made, highlights the selected point and updates the *COGO procedure parameter form's* initial From Point field's with the values from the point selected if applicable. [selected point is a measured point]Centers display on selected point at the same scale as display is at when selection is made, opens the *Record Survey Data Spreadsheet* and highlights the selected point, both on the display and in the spreadsheet.

	See the MM use case, "3.06. Display/Edit Record line data in spreadsheet format"

Add A Line COGO Parameter Form

COGO Method: ( ) Dir./Dist. ( ) Intersect ( ) Proportion ( ) Offset ( ) Average (•) Add a Line ( ) Aliquot COGO wizard [ ] Multiple Selection Editor

---

Section Subdivision: [√] Subdivide by rules. **Level of automatic subdivision:** [10 ac – 1/64 cors] ↓ **Selection Buffer Level:** [10 ac – 1/64 cors] ↓

From Point: [*Point Identifier*] [*x, y, z*] **Datum Mode:** [Projection] ↓ **Computation mode**: ( ) Geodetic (•)Plane

Direction: [*Direction Reference*] ↓ [*Direction value*] **Format:** [DDMMSS.s] ↓ **Elevation Units:** [feet] ↓

Feature Reference: [To Point *[*Point ID*] [*x, y, z*] **]** ↓

Parallel to line *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*]

Weighted mean bearing *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*] and *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*]

Horiz. angle from Backsight *[*Point ID*] [*x, y, z*]. Turn angle clockwise: [*angle value*]

Distance: [*Distance value*] **Unit:** [Survey Feet] ↓ **Type:** [Sea Level] ↓ **Offset to:** [Right/Left]↓

Feature Reference: [Pick Line *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*] **]** ↓

Pick two points *[Point ID] [*x, y, z*] to *[Point ID] [*x, y, z*]

From Point: [*Point Identifier*] [*x, y, z*] **Datum Mode:** [Projection] ↓ **Computation mode**: ( ) Geodetic (•)Plane

Direction: [*Direction Reference*] ↓ [*Direction value*] **Format:** [DDMMSS.s] ↓ **Elevation Units:** [feet] ↓

Feature Reference: [To Point *[*Point ID*] [*x, y, z*] **]** ↓

Parallel to line *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*]

Weighted mean bearing *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*] and *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*]

Horiz. angle from Backsight *[*Point ID*] [*x, y, z*]. Turn angle clockwise: [*angle value*]

Distance: [*Distance value*] **Unit:** [Survey Feet] ↓ **Type:** [Sea Level] ↓ **Offset to:** [Right/Left]↓

Feature Reference: [Pick Line *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*] **]** ↓

Pick two points *[Point ID] [*x, y, z*] to *[Point ID] [*x, y, z*]

Proportion: [*Proportion value*]

(•) Midpoint

( ) Inverse-divided-by-Record of selected feature

( )Ratio of Total Distance

Points within tolerance :**[** List of *Point IDs, x, y, z; Δx,Δy,Δz;weigthts;* [√ avg] **]** ↓ **Tolerance:** [*value*]

New Point: [*Point ID*] [*x, y, z*] **Datum Display Mode:** [*Projection*] ↓ [√] Point created by extension-type intersection **[Find]**

[Delete] [Back] [Next] [Save] [Cancel]

MM 1.08 Construct line feature – spiral curve

High Level Description	
Purpose	Construct a spiral curve centerline feature based on input of curve parameters, either manually or by selection of existing features.
Actors	System users
Precondition	There are existing point and line features. Boundary line defined by spiral curve needs to be input into system.
Postcondition	Curve is calculated, displayed and added to data set.
Description	Creates a curved line feature (arc), based on parameters, for closure of a polygon.
Cross reference	Uses: Extends:
Development Implications and Considerations	
Data considerations	
Requirements addressed	

Primary Scenario	
Actor Action	**System Response**
1. This use case begins when the user selects the "Spiral Curve" COGO procedure button on the COGO Procedure Parameter Form.	2. Present the Spiral Curve COGO Procedure Parameter Form.
3. Select/Edit From Point and optionally, To Point of the spiral's Long Chord. Input length of spiral curve. [One end of spiral is a tangent line] Select tangent line. [One end of spiral is a simple curve feature] Select the simple curve feature. [One end of spiral is a simple curve definition] Input point identifiers, coordinates, direction and/or distance, by manual input or by selection of features from display. Input one of the following additional parameters if needed: Delta Angle (Δ), Degree of curve, Curve Definition (arc or chord), Arc Length, External, or Mid Ordinate. Select input, computation and display modes. [One end of spiral is not a tangent line or a simple curve line] Input the radius distance and curve direction at the end that is not straight or circular. Direction values can be Azimuth or Bearings and formats can be Radians, Grad, DDMMSS.s, DD.ddddd, DDMM.mmm, etc. Distance units can be meters, international meters, international feet, U.S. Survey feet	4. Updates appropriate *COGO procedure parameter form* fields with values of selected features as each feature is selected, and highlights the selected features on the graphic display. Manual input of existing feature's point identifiers or coordinates selects and highlights that feature. Steps through each input field as form is filled out, starting with initial From Point. Features can be selected from graphics display when an input field is the focus. Selecting line(s) fills in From point and To point fields when the focus is the From point field. Computes and graphically displays highlighted new curve line feature(s) between From Point and To Point of Long Chord. System generates a point ID that is based on sequential or other rules as a default value for the new point. System derives all parameters from a base of information pieces. For example the selection of a tangent line and a long chord will provide the direction of the curve, right or left. Another example is that all dimensions of a curve can be calculated from any two dimensions unless the combination of those dimensions are the Radius and the Degree of curvature.

meters, international feet, U.S. Survey feet, Chains, etc. Elevation units can be feet or meters. Type of input for coordinates depends on Datum mode selected. Computation Mode depends on type selected, geodetic or plane. Type of display for New Point coordinates depends on Datum Display mode selected. Examples of selection from display for direction and/or distance are: Select a to point to determine direction and/or distance. Select any position on either side of a defined tangent line to indicate direction. Select a line for parallel to line to determine direction. Select two lines to determine a weighted mean direction. Select a backsight point or line for spiral angle input to determine direction. Select a line of the same length as the desired distance. Select two points to determine the desired distance. Select any new position from display for a to point. Defaults are the last selected values and modes. User selects an existing curve as a means of populating the curve elements of a curve being constructed. This would bring the radius, length, etc. over as well as concavity, although the concavity would be overwritten if the tangent lines of the new curve indicate otherwise. This feature would streamline the process of entering in fillets of a subdivision because fillets are generally a standard size. Curves can be selected as features on the graphic screen as well as entries in the Feature Selection Navigator. While populating the concavity field, user selects a point Right or Left of the long chord to indicate what side of the long chord the curve exists. Or if the curve is plotted with the wrong concavity, just drag the midpoint of the curve and drop it onto the other side of the long chord.	When all necessary parameters are filled in, the computations are performed and an answer is displayed in the *COGO procedure parameter form's* New Point field. As changes are made in parameters the system computes and displays new values in the New Point, Beginning radius, Ending radius, Arc Length fields. The Long Chord bearing and distance is made available to the Least Square process. Update graphic display, including notification and symbolization of pre-existing points or IDs within distance tolerance. Prompt to save resulting coordinates and/or computations. [parameters are incorrect] Go to 3 [parameters correct] Go to 5
5. User selects appropriate action button. Note *COGO Procedure Parameter Form* stays available for further computations until [Save]	6. Process according to input from actor. **[Delete]** Deletes the current computations and parameters and opens the next logical *COGO*

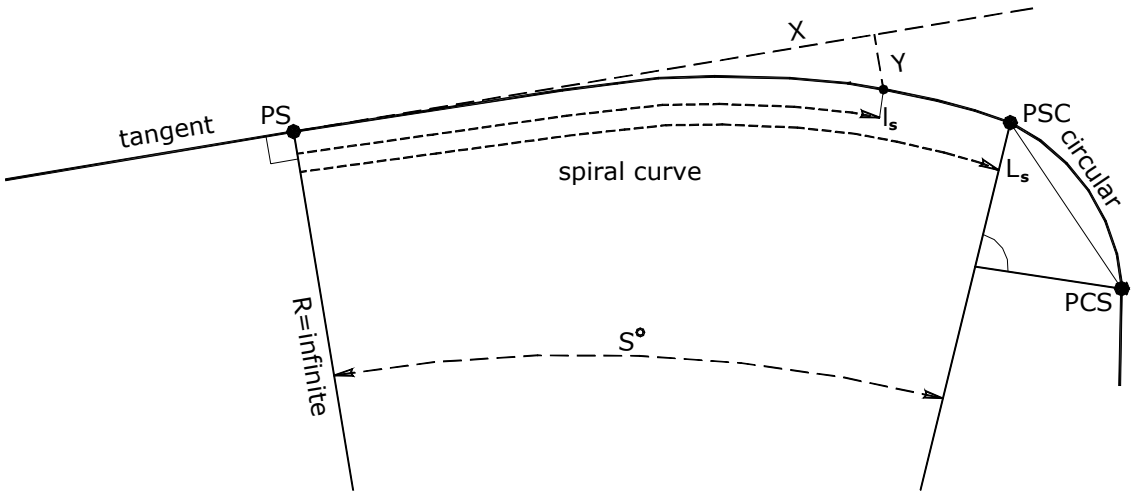
or [Close] button is selected.	*Procedure Parameter Form* for editing. **[Back]** Go to the *COGO Procedure Parameter Form* for last computation. Back does not save current *COGO Procedure Parameter Form's* parameters and computations, but keeps them in memory. **[Next]** default; same as save except, goes to step 5 and leaves *COGO Procedure Parameter Form* available for editing**.** Also acts as [Forward] selection, to step forward through *COGO Procedure Parameter Forms*. **[Save]** save coordinates with appropriate point ID (may be new or replacement of existing) and save new line features, also save *computations* (to support audit; retrievable for layout, reconstruction and then closes the *COGO Procedure Parameter Form*. **[Cancel]** Exits without saving changes and closes the *COGO Procedure Parameter Form*.

Secondary Scenario	
Actor Action	**System Response**
Surveyor needs to establish a *field survey* before performing calculations.	Step 1 or 2. Use ***SM-2.01 Field Survey Setup*** to retrieve/apply *field survey setup file* and retrieve/setup *measurement data set* and reference data set.
Surveyor needs to establish an *observation set* to select input features or save output features.	Step 4. Use ***SM-4.01 Collect Field Survey Data In Real Time*** and retrieve/setup *observation set*.
Actor needs to reconstruct a feature or duplicate a procedure from existing *COGO procedures.*	Step 1. Assist actor to find and retrieve feature and/or *COGO procedure*.
New point violates *Point-ID duplication protection.*	Step 3. [point ID already exists] retrieve *computation* for existing *point*, displays both the existing points and the new point's *COGO procedure parameter forms*. Actor modifies as needed.
New point violates *procedure duplication protection.*	Step 3. [a *point* has previously been calculated with an equivalent *computation*] prompt actor to accept existing point's procedures or rename ID. Cannot save procedures unless procedures or ID is changed.
Locate a point in the Area of Interest and center on display, inputs a New Point into the point ID or coordinates field and selects Find button.	Centers display on selected point at the same scale as display is at when selection is made, highlights the selected point and updates the *COGO procedure parameter form's* initial From Point field's with the values from the point selected if applicable. [selected point is a measured point]Centers display on selected point at the same scale as display is at when selection is made, opens the *Record Survey Data Spreadsheet* and highlights the selected point, both on the display and in the spreadsheet. See the MM use case, "3.06. Display/Edit Record line data in spreadsheet format"
New point is computed on line between existing points.	Step 4. [geodetic mode] moves point to geodetic line and computes new line features.

Present day GMM does not show any curves, but allows a place to store simple and spiral curves. See McKay's Core Data Elements for a full complement of curve attributes.

Definitions: a spiral is a clothoid curve also known as easement or transition curves
P.S. = Point of change from tangent to spiral
P.S.C. = Point of change from spiral to simple curve
P.C.S = Point of change from simple to spiral curve
P.T. = Point of change from spiral to tangent
Y = Abscissa or distance from the P.S. to a point on the tangent opposite the P.S.C.
X = The ordinate or tangent offset of the P.S.C.
S = The central angle of the whole spiral
s = The central angle from the P.S. to any given point on the spiral.
L_s = Arclength of spiral
l_s = Arclength along spiral to any given point
n = number of terms, from 1 to any number n (n=8 is acceptable)

Formulae:
S° = $DL_s/200$, where D is the degree of curvature of the circular
δ = S, in radians
$X = l_s \bullet \Sigma \left(\delta^{2n-1} / (2n-1)! \bullet (4n-1) \bullet (-1)^{n+1}\right)$
$Y = l_s \bullet \Sigma \left(\delta^{2n-2} / (2n-2)! \bullet (4n-3) \bullet (-1)^{n+1}\right)$



Example: n = 4 terms

$X = l_s \left(\delta/3 - \delta^3/7(3!) + \delta^5/11(5!) - \delta^7/15(7!) \text{ --- } \right)$

$Y = l_s \left(1 - \delta^2/5(2!) + \delta^4/9(4!) - \delta^6/13(6!) \text{ --- } \right)$

SPIRAL CURVE PARAMETER FORM .

Curve Type: ( ) Circular ( ) Spiral ( ) Offset to spiral centerline ( ) Medial line

---

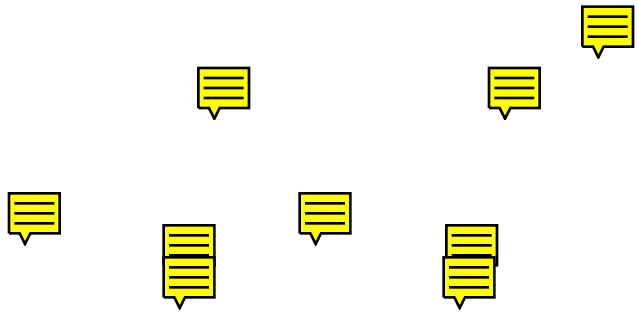
SPIRAL CURVE:

Spiral Begin Point: [*Point Identifier*] [x, *y, z*] **Datum Mode:** [Projection] ↓ **Concave to:** [Right]↓

Chord Direction: [*Direction Reference*] ↓ [*Direction value*] **Format:** [DDMMSS.s] ↓
Feature Reference: Tangent line *[*Point ID*] [x, *y, z*] to *[*Point ID*] [x, *y, z*]
Spiral End Point: [*Point Identifier*] [x, *y, z*] **Datum Mode:** [Projection] ↓

Spiral Long Chord Distance: [*Distance value*] **Unit:** [Survey Feet] ↓ **Type:** [Sea Level] ↓
Feature Reference: Pick Line or 2 pts *[*Point ID*] [x, *y, z*] to *[*Point ID*] [x, *y, z*]
Pick similar curve *[*Point ID*] [x, *y, z*] to *[*Point ID*] [x, *y, z*]

Arc Length: [*Distance value*] **Unit:** [Survey Feet] ↓ **Type:** [Sea Level] ↓
Radius at spiral beginning: [*Distance value*] **Unit:** [Survey Feet] ↓ **Type:** [Sea Level] ↓ [√] Infinite
Radius at spiral end: [*Distance value*] **Unit:** [Survey Feet] ↓ **Type:** [Sea Level] ↓ [√] Infinite



MM 1.09 Construct line feature – offset to spiral curve

High Level Description	
Purpose	Construct a line offset to a spiral curve centerline feature based on input of offset curve parameters, either manually or by selection of existing features.
Actors	System users
Precondition	The parameters of the centerline spiral curve have been input through Use Case 1.08. The dimensions of the offset to spiral curve centerline needs to be input into system.
Postcondition	Curve is calculated, displayed and added to data set.
Description	Creates a curved line feature, based on parameters, for closure of a polygon.
Cross reference	Uses: Extends: 1.04 Construct point and line features by offset from a straight line
Development Implications and Considerations	
Data considerations	
Requirements addressed	

Primary Scenario	
Actor Action	**System Response**
1. This use case begins when the user selects the "Offset to Spiral Curve" COGO procedure button on the COGO Procedure Parameter Form.	2. Present the Offset to Spiral Curve COGO Procedure Parameter Form.
3. Identify the spiral curve centerline feature upon which this offset is based. Select/Edit From Point and optionally, To Point of the spiral offset's Long Chord. Input length and direction of offset. Distance units can be meters, international meters, international feet, U.S. Survey feet, Chains, etc. Input for coordinates depends on Datum mode selected. Computation Mode depends on type selected, geodetic or plane. Type of display for New Point coordinates depends on Datum Display mode selected. Examples of selection from display for direction and/or distance are: Select a to point to determine direction and/or	4. Updates appropriate *COGO procedure parameter form* fields with values of selected features as each feature is selected, and highlights the selected features on the graphic display. Manual input of existing feature's point identifiers or coordinates selects and highlights that feature. Steps through each input field as form is filled out, starting with initial From Point. Features can be selected from graphics display when an input field is the focus. Selecting line(s) fills in From point and To point fields when the focus is the From point field. Computes and graphically displays highlighted new curve line feature(s) between From Point and To Point of the spiral endpoints. System generates a point ID that is based on sequential or other rules as a default value for the new point. System derives all parameters from a base of

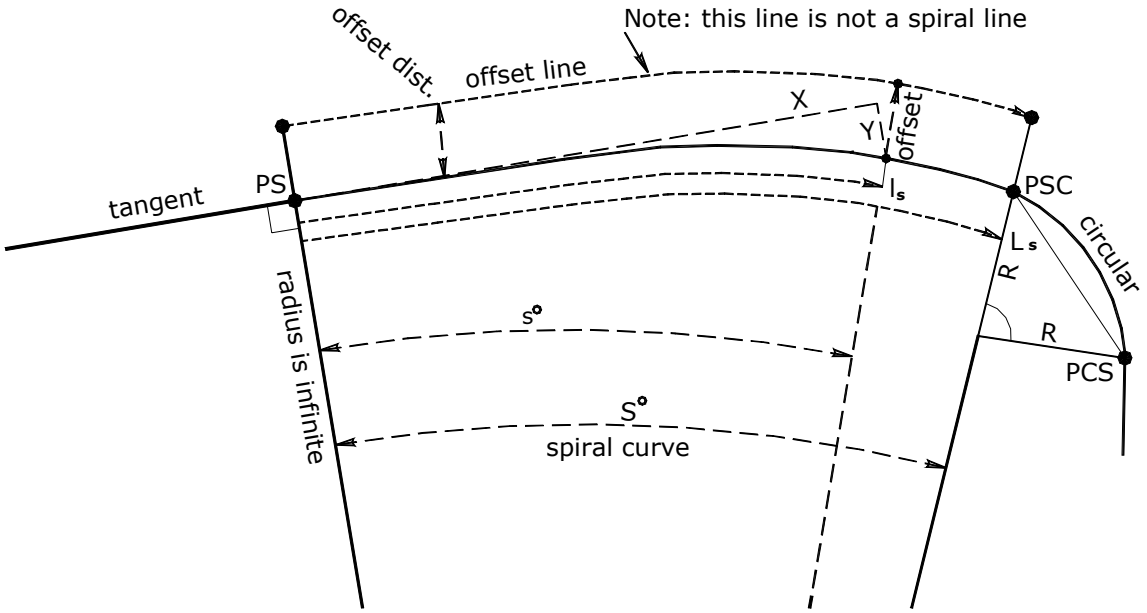
distance. Select any position on either side of a defined tangent line to indicate direction. Select a line of the same length as the desired distance. Select two points to determine the desired distance. Select any new position from display for a to point. Defaults are the last selected values and modes. User selects an existing curve as a means of populating the curve elements of a curve being constructed. This would bring the radius, length, etc. over as well as concavity, although the concavity would be overwritten if the tangent lines of the new curve indicate otherwise. This feature would streamline the process of entering in fillets of a subdivision because fillets are generally a standard size. Curves can be selected as features on the graphic screen as well as entries in the Feature Selection Navigator. While populating the concavity field, user selects a point Right or Left of the tangent line to indicate what side of the long chord the curve exists. Or if the curve is plotted with the wrong concavity, just drag the midpoint of the curve and drop it onto the other side of the tangent line.	information pieces. For example the selection of a tangent line and a long chord will provide the direction of the curve, right or left. Another example is that all dimensions of a curve can be calculated from any two dimensions unless the combination of those dimensions are the Radius and the Degree of curvature. The bearing and distance of the spiral offset's long chord is made available to the least square adjustment process. When all necessary parameters are filled in, the computations are performed and an answer is displayed in the *COGO procedure parameter form's* New Point field. As changes are made in parameters the system computes and displays new values in the New Point, Offset Distance fields. Update graphic display, including notification and symbolization of pre-existing points or IDs within distance tolerance. Prompt to save resulting coordinates and/or computations. [parameters are incorrect] Go to 3 [parameters correct] Go to 5
5. User selects appropriate action button. Note *COGO Procedure Parameter Form* stays available for further computations until [Save] or [Close] button is selected.	6. Process according to input from actor. **[Delete]** Deletes the current computations and parameters and opens the next logical *COGO Procedure Parameter Form* for editing. **[Back]** Go to the *COGO Procedure Parameter Form* for last computation. Back does not save current *COGO Procedure Parameter Form's* parameters and computations, but keeps them in memory. **[Next]** default; same as save except, goes to step 5 and leaves *COGO Procedure Parameter Form* available for editing**.** Also acts as [Forward] selection, to step forward through *COGO Procedure Parameter Forms*. **[Save]** save coordinates with appropriate point ID (may be new or replacement of existing) and save new line features, also save *computations* (to support audit; retrievable for layout, reconstruction and then closes the *COGO Procedure Parameter Form*. **[Cancel]** Exits without saving changes and closes the *COGO Procedure Parameter Form*.

Secondary Scenario	
Actor Action	**System Response**
Surveyor needs to establish a *field survey* before performing calculations.	Step 1 or 2. Use ***SM-2.01 Field Survey Setup*** to retrieve/apply *field survey setup file* and retrieve/setup *measurement data set* and reference data set.
Surveyor needs to establish an *observation set* to select input features or save output features.	Step 4. Use ***SM-4.01 Collect Field Survey Data In Real Time*** and retrieve/setup *observation set*.
Actor needs to reconstruct a feature or duplicate a procedure from existing *COGO procedures.*	Step 1. Assist actor to find and retrieve feature and/or *COGO procedure*.
New point violates *Point-ID duplication protection.*	Step 3. [point ID already exists] retrieve *computation* for existing *point*, displays both the existing points and the new point's *COGO procedure parameter forms*. Actor modifies as needed.
New point violates *procedure duplication protection.*	Step 3. [a *point* has previously been calculated with an equivalent *computation*] prompt actor to accept existing point's procedures or rename ID. Cannot save procedures unless procedures or ID is changed.
Locate a point in the Area of Interest and center on display, inputs a New Point into the point ID or coordinates field and selects Find button.	Centers display on selected point at the same scale as display is at when selection is made, highlights the selected point and updates the *COGO procedure parameter form's* initial From Point field's with the values from the point selected if applicable. [selected point is a measured point]Centers display on selected point at the same scale as display is at when selection is made, opens the *Record Survey Data Spreadsheet* and highlights the selected point, both on the display and in the spreadsheet. See the MM use case, "3.06. Display/Edit Record line data in spreadsheet format"
New point is computed on line between existing points.	Step 4. [geodetic mode] moves point to geodetic line and computes new line features.

Present day GMM does not show any curves, but allows a place to store simple and spiral curves. See McKay's Core Data Elements for a full complement of curve attributes.

Definitions:
P.S. = Point of change from tangent to spiral
P.S.C. = Point of change from spiral to simple curve
P.C.S = Point of change from simple to spiral curve
P.T. = Point of change from spiral to tangent
Y = Abscissa or distance from the P.S. to a point on the tangent opposite the P.S.C.
X = The ordinate or tangent offset of the P.S.C.
S = The central angle of the whole spiral
s = The central angle from the P.S. to any given point on the spiral.
L_s = Arclength of spiral
l_s = Arclength along spiral to any given point
R = radius at the end of the spiral, usually a circular curve
r = radius of the spiral at any given point

Formulae:
$S° = DL_s/200$, where D is the degree of curvature of the circular
$\mathbf{s}° = l_s^2/2RL$
$r/R = L_s/l_s$
δ = S, in radians
$X = l_s \bullet \Sigma(\delta^{2n-1} / (2n-1)! \bullet (4n-1) \bullet (-1)^{n+1})$, where acceptable n values are 4 through 8.
$Y = l_s \bullet \Sigma(\delta^{2n-2} / (2n-2)! \bullet (4n-3) \bullet (-1)^{n+1})$, where acceptable n values are 4 through 8.



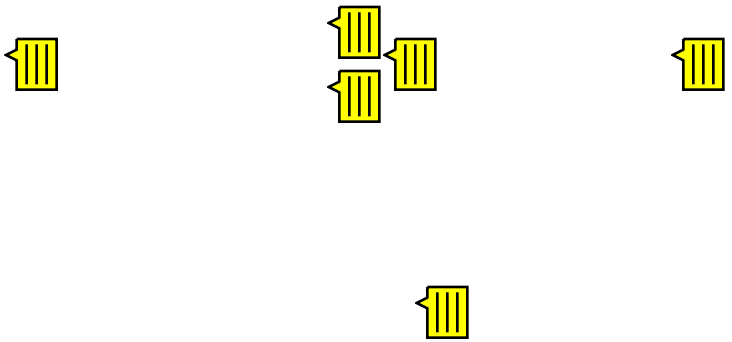
SPIRAL OFFSET - CURVE PARAMETER FORM Cont.

Curve Type: ( ) Circular ( ) Spiral ( ) Offset to spiral centerline ( ) Medial line

---

SPIRAL OFFSET:

Spiral Offset Begin Point: [*Point Identifier*] [x, *y, z*] **Datum Mode:** [Projection] ↓
Offset distance: [*Distance value*] **Unit:** [Survey Feet] ↓ **Type:** [Sea Level] ↓ **Offset direction:** [Right]
Spiral Offset End Point: [*Point Identifier*] [x, *y, z*] **Datum Mode:** [Projection] ↓



MM 1.10 Construct line feature – median line curve

High Level Description	
Purpose	Construct a median line curve feature based on input of median line parameters, either manually or by selection of existing features.
Actors	System users
Precondition	The points that define the median line exist as features.
Postcondition	Curve is calculated, displayed and added to data set. Also, straight lines between nonadjacent curves would be created as a result of this operation.
Description	Creates a curved line feature, based on parameters, for closure of a polygon.
Cross reference	Uses: Extends:
Development Implications and Considerations	
Data considerations	
Requirements addressed	

Primary Scenario	
Actor Action	**System Response**
1. This use case begins when the user selects the "Median Line Curve" COGO procedure button on the COGO Procedure Parameter Form.	2. Present the Median Line Curve COGO Procedure Parameter Form. Form has an option to calculate all curves possible from a selection.
3. Select the three lines that define the median line, the lines going into and out of the focus and the line or lines that will contain the From Directrix and To Directrix. Lines can be selected as features on the graphic screen as well as entries in the Feature Selection Navigator. [It should be noted that the user may not be able to ascertain exactly which lines of the river banks are necessary to define the curve in question. The user should be able to highlight all lines on the right bank and the left bank, the final bounding lines, and then let the system sort out which lines are appropriate to define each curve and which lines define the straight portions of the median line. This may be no small programming task, but it is a greater task for all the users to figure out all the puzzles without knowing the rules and strategies.]	4. Updates appropriate *COGO procedure parameter form* fields with values of selected features as each feature is selected, and highlights the selected features on the graphic display. Steps through each input field as form is filled out, starting with initial line. Features can be selected from graphics display when an input field is the focus. Computes and graphically displays highlighted From Point and the To Point of the median line curve and the new curve line feature(s) between From Point and the To Point. Update graphic display, including notification and symbolization of pre-existing points or IDs within distance tolerance. Prompt to save resulting computations. [parameters are incorrect] Go to 3 [parameters correct] Go to 5
5. User selects appropriate action button. Note *COGO Procedure Parameter Form* stays available for further computations until [Save] or [Close] button is selected.	6. Process according to input from actor. **[Delete]** Deletes the current computations and parameters and opens the next logical *COGO Procedure Parameter Form* for editing. **[Back]** Go to the *COGO Procedure Parameter Form* for last computation. Back does not save current *COGO Procedure Parameter Form's* parameters and computations, but keeps them in memory.

	[Next] default; same as save except, goes to step 5 and leaves *COGO Procedure Parameter Form* available for editing**.** Also acts as [Forward] selection, to step forward through *COGO Procedure Parameter Forms*. **[Save]** save new line features, also save *computations* (to support audit; retrievable for layout, reconstruction and then closes the *COGO Procedure Parameter Form*. **[Cancel]** Exits without saving changes and closes the *COGO Procedure Parameter Form*.

Secondary Scenario	
Actor Action	**System Response**
Surveyor needs to establish a *field survey* before performing calculations.	Step 1 or 2. Use ***SM-2.01 Field Survey Setup*** to retrieve/apply *field survey setup file* and retrieve/setup *measurement data set* and reference data set.
Surveyor needs to establish an *observation set* to select input features or save output features.	Step 4. Use ***SM-4.01 Collect Field Survey Data In Real Time*** and retrieve/setup *observation set*.
Actor needs to reconstruct a feature or duplicate a procedure from existing *COGO procedures.*	Step 1. Assist actor to find and retrieve feature and/or *COGO procedure*.
Locate a point in the Area of Interest and center on display, inputs a New Point into the point ID or coordinates field and selects Find button.	Centers display on selected point at the same scale as display is at when selection is made, highlights the selected point and updates the *COGO procedure parameter form's* initial From Point field's with the values from the point selected if applicable. [selected point is a measured point]Centers display on selected point at the same scale as display is at when selection is made, opens the *Record Survey Data Spreadsheet* and highlights the selected point, both on the display and in the spreadsheet. See the MM use case, "3.06. Display/Edit Record line data in spreadsheet format"

Present day GMM does not support median line curves. See McKay's Core Data Elements for a full complement of curve attributes.

Median line – A line that is equidistant between the lines that define the right and left banks of a river. Also known as a medial line. It is used to determine the ownership line in abandoned channels.

Note: while the median line can be the straight bisect of the angles formed by opposite sides, it becomes a parabolic curve to transition between bisects. This happens near every angle point along either bank and that angle point is called the focus. Two lines drawn from the focus and toward the other bank, perpendicular to the lines going into or out of the focus will intersect the bisect line(s) at points that form the "From" and "To" endpoints of the median line curve. Continuing from those endpoints toward the other bank, on normal lines to that bank will form two points each known as a directrix that we are calling the From directrix and the To directrix.

Refer to pp 346-356 of River & Lake Boundaries by James A. Simpson, 1994. Plat Key Publishing Co. PO Box 4419, Kingman, Arizona 86402

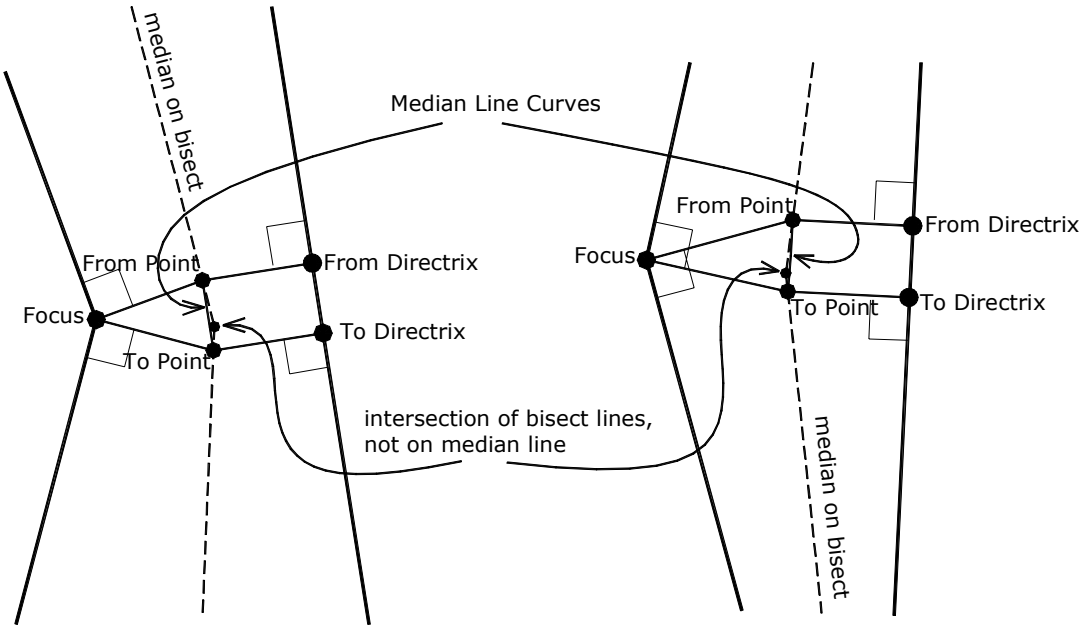


Fig. 1 - Median lines provide a transition between the bisects of two banks of an abandoned river.

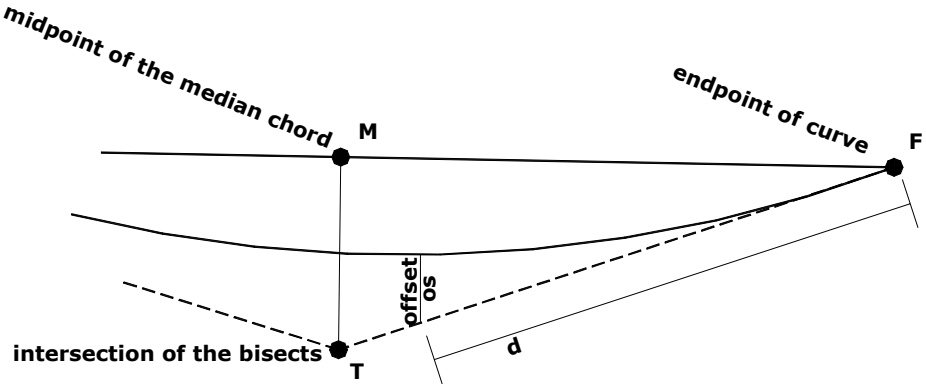


Fig. 2 – Any point along the curve can be calculated, formula below.

Offset OS = (d^2 / (distance F to T)^2) - (distance from T to M)/2

where d = any distance along the bisect line.

The offset distance is applied along a line parallel to the line T to M.

MEDIAN LINE - CURVE PARAMETER FORM

Curve Type: ( ) Circular ( ) Spiral ( ) Offset to spiral centerline ( ) Medial line

---

MEDIAN LINE CURVE:

Directrix Begin Point: [*Point Identifier*] [x, *y, z*] **Datum Mode:** [Projection] ↓
Directrix End Point: [*Point Identifier*] [x, *y, z*] **Datum Mode:** [Projection] ↓
Focus Point: [*Point Identifier*] [x, *y, z*] **Datum Mode:** [Projection] ↓
Focus Backsight Point: [*Point Identifier*] [x, *y, z*] **Focus Foresight Point:** [*Point Identifier*] [x, *y, z*]

MM 1.11 Section Subdivision

High Level Description	
Purpose	Automatically subdivides PLSS sections to the 40 acre or below level, using standard methods and rules for subdivision of sections and any additional rules set by the COGO Procedure Parameter Form.
Actors	System users
Precondition	There are no coordinates for subdivision points. The points necessary to do automatic subdivision exist or can be computed either by the standard subdivision of section rules or the rules stored by the COGO Procedure Parameter Form.
Postcondition	The computed points have coordinates and IDs.
Description	Computes subdivision points using the standard rules for section subdivision and the rules stored by the COGO Procedure Parameter Form to the level specified by the user. The system writes a report of methods used to compute each point.
Cross reference	Uses: 2.01, 2.04, 2.05, 2.06, 2.07, 2.08 (For raw data islands) Extends: 1.01,1.02
Development Implications and Considerations	Rules for subdivision See McKay's subdivide3.doc: Procedures for Automatic Subdivision of a Section
Data considerations	Islands of raw data
Requirements addressed	

Primary Scenario	
Actor Action	**System Response**
1. This use case begins when the user checks the "Automatic subdivision by rules box" COGO procedure button on the COGO Procedure Parameter Form. User selects the desired level of subdivision. Type of display for New Point coordinates depends on Datum Display mode selected.	2. Present the COGO Procedure Parameter Form with the "Subdivide by rules" field boxes enabled. Computes all section subdivision based on the standard rules of subdivision and the rules stored with any applicable COGO Procedure Parameter Forms for all points in the selected area of interest. Prompt to save resulting coordinates and/or computations. New Point field is not updated, but is available for locating a point. [parameters are incorrect] Go to 1 [parameters correct] Go to 7 [further subdivision needed] Go to 3
3. User needs to perform further subdivision and selects polygons to further subdivide and selects Aliquot Subdivision.	4. System provides Aliquot Subdivision window, which allows the user to select the level and direction of subdivision for the selected polygons. (See Aliquot Selection window sample)
5. The user selects the level and direction of subdivision for selected polygons in the Aliquot Subdivision window.	6 The system computes the aliquot subdivision for the selected polygons. Prompt to save resulting coordinates and/or computations. Go to 7.
7. User selects appropriate action button. Note *COGO Procedure Parameter Form* stays available for further computations until **[Save]**	8. Process according to input from actor. **[Back]** Go back through the additional methods, which were saved by the *COGO Procedure*

or **[Close]** button is selected.	*Parameter Form*. **[Save]** save coordinates with appropriate point ID (may be new or replacement of existing) and save new line features, also save *computations* (to support audit; retrievable for layout, reconstruction and then closes the *COGO Procedure Parameter Form*. **[Cancel]** Exits without saving changes and closes the *COGO Procedure Parameter Form*.

Secondary Scenario	
Actor Action	**System Response**
Points can not be computed; standard rules do not apply and there are not rules stored by the COGO Procedure Parameter Forms	Highlights polygons, which cannot be subdivided to specified level.
Locate a point in the Area of Interest and center on display, inputs a New Point into the point ID or coordinates field and selects Find button.	Centers display on selected point at the same scale as display is at when selection is made, highlights the selected point and updates the *COGO procedure parameter form's* initial From Point field's with the values from the point selected if applicable. [selected point is a measured point]Centers display on selected point at the same scale as display is at when selection is made, opens the *Record Survey Data Spreadsheet* and highlights the selected point, both on the display and in the spreadsheet. See the MM use case, "3.06. Display/Edit Record line data in spreadsheet format"
Finds a raw data island flag	Uses generated subdivision coordinates to incorporate island raw data, and performs least squares adjustment. See 2.07 – Least Squares Adjustment

Subdivision COGO Parameter Form

COGO Method: ( ) Dir./Dist. ( ) Intersect ( ) Proportion ( ) Offset ( ) Average ( ) Add a Line ( ) Aliquot COGO wizard [ ] Multiple Selection Editor

---

Section Subdivision: [√] Subdivide by rules. **Level of automatic subdivision:** [10 ac – 1/64 cors] ↓ **Selection Buffer Level:** [10 ac – 1/64 cors] ↓

From Point: [*Point Identifier*] [*x, y, z*] **Datum Mode:** [Projection] ↓ **Computation mode**: ( ) Geodetic (•)Plane

Direction: [*Direction Reference*] ↓ [*Direction value*] **Format:** [DDMMSS.s] ↓ **Elevation Units:** [feet] ↓

Feature Reference: [To Point *[*Point ID*] [*x, y, z*] **]** ↓
Parallel to line *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*]
Weighted mean bearing *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*] and *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*]
Horiz. angle from Backsight *[*Point ID*] [*x, y, z*]. Turn angle clockwise: [*angle value*]

Distance: [*Distance value*] **Unit:** [Survey Feet] ↓ **Type:** [Sea Level] ↓ **Offset to:** [Right/Left]↓

Feature Reference: [Pick Line *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*] **]** ↓
Pick two points *[Point ID] [*x, y, z*] to *[Point ID] [*x, y, z*]

From Point: [*Point Identifier*] [*x, y, z*] **Datum Mode:** [Projection] ↓ **Computation mode**: ( ) Geodetic (•)Plane

Direction: [*Direction Reference*] ↓ [*Direction value*] **Format:** [DDMMSS.s] ↓ **Elevation Units:** [feet] ↓

Feature Reference: [To Point *[*Point ID*] [*x, y, z*] **]** ↓
Parallel to line *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*]
Weighted mean bearing *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*] and *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*]
Horiz. angle from Backsight *[*Point ID*] [*x, y, z*]. Turn angle clockwise: [*angle value*]

Distance: [*Distance value*] **Unit:** [Survey Feet] ↓ **Type:** [Sea Level] ↓ **Offset to:** [Right/Left]↓

Feature Reference: [Pick Line *[*Point ID*] [*x, y, z*] to *[*Point ID*] [*x, y, z*] **]** ↓
Pick two points *[Point ID] [*x, y, z*] to *[Point ID] [*x, y, z*]

Proportion: [*Proportion value*]
(•) Midpoint
( ) Inverse-divided-by-Record of selected feature
( )Ratio of Total Distance

Points within tolerance *:***[** List of *Point IDs, x, y, z; Δx,Δy,Δz;weigthts;* [√ avg] **]** ↓ **Tolerance:** [*value*]
New Point: [*Point ID*] [*x, y, z*] **Datum Display Mode:** [*Projection*] ↓ [√] Point created by extension-type intersection **[Find]**

[Delete] **[Back]** **[Next]** **[Save]** **[Cancel]**

MM 1.12 Inspect and Edit multiple features

High Level Description	
Purpose	Create formatted spreadsheet(s), depending on selected features data type, for all the features displayed within the graphics screen. Assist user to edit multiple features selected in the spreadsheet(s). Allows for selected feature(s) in the COGO Feature Selection Navigator Spreadsheet to have the parameters presented in the COGO Procedure Parameter Form for inspection and/or editing. Allows for selected feature(s) in the Record Survey Data Spreadsheet to have the parameters presented in the Record Survey Data Parameter Form for inspection and/or editing. Allows selected feature(s) in the Control Data Spreadsheet to have the parameters presented in the Control Parameter Form for inspection and/or editing.
Actors	System users
Precondition	User needs to inspect or edit feature(s) and their parameters.
Postcondition	Features and their parameters have been inspected or edited.
Description	A list of all features in the graphic display is sent to spreadsheet type interfaces showing an abbreviated form of major parameters. User can select features from this list for mass inspection and editing. User has choice to further inspect any point or line's full parameters by double clicking its entry. Depending on the type of selected feature, the appropriate Parameter Form is presented.
Cross reference	Uses: Extends: 1.11, 3.06
Development Implications and Considerations	
Data considerations	
Requirements addressed	

Primary Scenario	
Actor Action	**System Response**
1. This use case begins when the user selects the Inspect or Edit multiple features function (Selection Editor).	2. A list of all features in the graphic display is sent to a spreadsheet type interfaces showing an abbreviated form of major parameters, including any features currently flagged not visible. The selected feature(s) data spreadsheet(s) is presented. For examples, see the Samples.xls spreadsheet. Assist user in selecting a subset of listed features to be marked for processing.
3. User selects features (rows) to be edited, from the appropriate spreadsheet, for multiple editing. User can clear a selected feature by reselecting a highlighted feature (toggle). The appropriate Parameter Form(s) for selected/highlighted features (rows) can be opened for editing. User has choice to further inspect and even edit any point or line's full parameters by double clicking its entry. User can zoom or pan display. User can choose to display previously hidden	4. Updates display and list with new highlighting for selected features. [user edits value(s) of selected feature(s) in the spreadsheet] Updates feature(s) value(s) for the selected features in the spreadsheet. [user choose to display Parameter Form's] The appropriate Parameter Form(s) for the selected feature(s) is presented. User can edit feature(s) and return. [user zooms or pans to different display] When the spreadsheet is made active, the list is refreshed to contain only items in screen plus items that had been

features. Examples of selections for subset are: ➢ Standard "windows" type of selections from a list, i.e. holding down shift key while scrolling to make selections. ➢ Select SELECT ALL or CLEAR ALL button. ➢ Selection of features from display by picks, individually or by windowing. ➢ Selection of a marked feature from the display or list unmarks that feature.	previously marked in list (Cumulative selection). Update graphic display, including notification and symbolization of pre-existing points or IDs within distance tolerance. Give user option of SELECT ALL or CLEAR ALL features on list. [list is incorrect] Go to 3 [list is correct] Go to 5
5. Select SAVE SELECTED LIST features.	6. Respond to user prompts by saving the correct parameters. **[SAVE SELECTED LIST]** Saves a list of selected features for reuse. (Not the spreadsheet) Also, save parameters of the edits. Prompt to save resulting coordinates and/or computations. [create another list of features] Go to 3 [lists are complete] Go to 7
7. User selects appropriate action button. Prompt user to run adjustments.	8. Process according to input from actor. The system analyzes the edits and calls Use Case 2.07 Least Square Adjustment if necessary, and runs other necessary computations (corner restoration and COGO). **[Next]** default; same as save except, goes to 3 **[Save]** save coordinates with appropriate point ID (may be new or replacement of existing) and save new line features, also save *computations* (to support audit; retrievable for layout, reconstruction and then closes the *COGO Procedure Parameter Form*. **[Cancel]** Exits without saving changes and closes the *COGO Procedure Parameter Form*.

Footnotes:

Not Visible = not moved to legal area description fabric

X = True

	Not in Technical Adjustment	Not in Cartographical Adjustment	Not Visible	Not Official Record Line	Corner Legal Status
RAW Lines	**X**	**X**	**X**	**X**	**NA**
Control Pts	**X**	**X**	**NA**	**NA**	**X**
Constructed Lines	**NA**	**NA**	**X**	**NA**	**NA**
Constructed pts	**X**	**X**	**NA**	**NA**	**NA**

COGO Feature Selection Navigator (1.12)

Construction Parameters

Method	Point ID	Line											Use Status			Audit		
		FROM Point ID	TO Point ID	Other From Point ID	Azimuth	Distance	Native Units	Other Distance	Native Units	Direction of Curve	Type	Line Direction Definition	USE in Technical adjustment	USE in Cartographic adjustment	NOT Visible	Modified By	Modified Date	Delete Date
Intersect	320320	300320	340320								P	S				dmckay	12/12/2000	
2nd Intersect		320300	320340								P	S						
Add a Line		320320	300320								P					dmckay	12/12/2000	
Add a Line		320320	340320								P					dmckay	12/12/2000	
Add a Line		320320	320300								P				X	dmckay	12/12/2000	
Add a Line		320320	320340								P				X	dmckay	12/12/2000	
Intersect	333540	400600	318600	400540							P	VM				dmckay	12/12/2000	
		400500	362500								P	VM				dmckay	12/12/2000	
2nd Intersect		889130	889150								G	R						
Add a Line		333540	400540								P					dmckay	12/12/2000	
Add a Line		333540	889130								P					dmckay	12/12/2000	
Add a Line		333540	889140								P					dmckay	12/12/2000	
Intersect	328560			360560	900000.0						P	A				dmckay	12/12/2000	
					895955.0							A				dmckay	12/12/2000	
2nd Intersect		889150	889170								G	R						
Add a Line		328560	560620								P					dmckay	12/12/2000	
Add a Line		328560	889160								P					dmckay	12/12/2000	
Add a Line		328560	889170								P					dmckay	12/12/2000	
Intersect	347520	400500	340500	400520							P	P				dmckay	12/12/2000	
2nd Intersect		889010	889020								G	S						
Add a Line		347520	400520								P					dmckay	12/12/2000	
Add a Line		347520	889010								P					dmckay	12/12/2000	
Add a Line		347520	889020															
Intersect	347520	400520			2695955.0						P	B				dmckay	12/12/2000	
2nd Intersect		889010	889020								G	S						
Add a Line		347520	400520								P					dmckay	12/12/2000	
Add a Line		347520	889010								P					dmckay	12/12/2000	
Add a Line		347520	889020								P							

MM 1.13 Corner Restoration Computations

High Level Description	
Purpose	Identify, analyze and balance data that will be used to restore lost corners.
Actors	System user
Precondition	Record boundary data and adjusted current field data are available.
Postcondition	New corner coordinates and line features are computed.
Description	User selects the data involved in the adjustment by picking lines off the spatial display or by utilizing a prompting sequence on the Corner Restoration Parameter Form. The system saves the data for later use by future processes. The data can be reviewed/edited through the *Corner Restoration Parameter Form* or through a spreadsheet format.
Cross reference	Uses: MM 3.05, 3.06, Extends: MM 1.01 thru 1.10,3.05,3.06
Development Implications and Considerations	
Data considerations	
Requirements addressed	

Primary Scenario	
Actor Action	**System Response**
1a. This use case begins when the user chooses a corner restoration method. The methods are: Compass Rule (Broken Boundary) Transit Rule (Grant Boundary) Record bearing/distance (One point control) Irregular Boundary Double Proportion Single Proportion Three point control Two point control	2. User is given an interface in which to select the lines whose record bearings and distances are used in the solution. [Spatial display] User is prompted to choose the line features. [Manual input display] User is presented with the *Corner Restoration Parameter Form*. This newly input data need or need not be included in least square adjustment (Refer to footnote below on flags.)
3. User selects features of the record data set to be adjusted by pick from the display or by manual input. This requires specifying the beginning point and ending point of each line or line sequence to be balanced. [User picks from spatial display] User picks line and point features. Note: Spatial selection tools include a "box" around the data or a polygonal "fence" around the data or selection of individual features. [User picks features manually] User enters Beginning point ID and Ending point ID into the	4. Updates the *Corner Restoration Parameter Form* fields with values of official record survey data of the selected line features as each line is selected, and highlights the selected features on the graphic display. Note: Values that are "official record" are indicated by an attribute known as the Boundary Defining Flag, see FGDC Cadastral Data Content Standard and McKay Core Data Elements. [Spatial input] Order line features sequentially from the Beginning point to the Ending point. [Manual input] Assists user in choosing which route to use. Fills in *Corner Restoration Parameter Form*

appropriate fields on the *Corner Restoration Parameter Form*. The user will also need to pick which route to take from the Beginning point from a list of the first leg of alternate routes.	record data fields. Each subsequent leg on the chosen route is automatically entered into the *Corner Restoration Parameter Form* record data fields until the Ending point is reached. Highlights selected features as they are entered into the *Corner Restoration Parameter Form*. When all necessary parameters are filled in, the computations are performed and an answer is displayed in the *Corner Restoration Parameter Form* Data Selection and Results of Adjustment Table fields. As changes are made in parameters the system computes and displays new values. [Distance_Correction or Direction_Correction exist for a record line] Apply any corrections before performing restoration method. These are called "index corrections" in the 1973 Manual of Surveying Instructions, page 135. Highlight those lines in the *Corner Restoration Parameter Form* that have corrections. Update graphic display, including notification and symbolization of pre-existing points or IDs within distance tolerance. Prompt to save resulting coordinates and/or computations. [parameters are incorrect] Go to 3 [parameters correct] Go to 5
5. User selects appropriate action button. Note *Corner Restoration Parameter Form* stays available for further computations until [Save] or [CANCEL] button is selected.	6. Process according to input from actor. **[Clear]** Clears the current computations and parameters and leaves the *Corner Restoration Parameter Form* open for editing. **[Back]** Go to the *Corner Restoration Parameter Form* for last computation of current session. Back does not save current *Corner Restoration Parameter Form's* parameters and computations, but keeps them in memory. **[Next]** default; same as save except, goes to step 3 and leaves *Corner Restoration Parameter Form* available for editing**.** Also acts as [Forward] selection, to step forward through *Corner Restoration Parameter Forms* for current session **[Save]** save coordinates with appropriate point IDs (replacing existing coordinate values) and save new line features, also save *computations* (to support audit; retrievable for layout, reconstruction and then closes the *Corner Restoration Parameter Form*. **[Cancel]** Exits without saving changes and closes the *Corner Restoration Parameter Form*.

Secondary Scenario	
Actor Action	**System Response**
Lines selected spatially are not continuous –	Step 4. Identify what endpoints are associated with

there are gaps that need to be filled.	each gap, then find the record that closes the gap. If the record is missing, then inform the user and wait until the user resolves the problem. In some cases the record is not found because the gap consists of two line segments. In the first cut of the software we will depend on the user to remedy, as the rules for resolving this situation could be complex. Go to step 3
Lines selected spatially have more than one route from beginning to end – there is ambiguity.	Step 4. Prompt user to deselect a feature on the spurious route. All lines in both directions from the selected feature to the next junctions will be deselected. Go to step 3
Route selected manually reaches junction of lines – there is ambiguity. This ambiguity is exists just after picking the Beginning and Ending points.	Dialogue interface is presented to user with a list of all possible routes from the junction and user picks the correct route. The correct route is appended to the list until it reaches the Ending point or another junction.
Record data does not exist – No values or values do not have Boundary Defining Flag set.	Step 4. User is sent to MM 3.06 Display/Edit Record Data

Footnotes:

Lost corner. A corner without physical evidence nearby to restore its most likely position. The most likely position is determined by:

1) The coordinate positions of adjacent monumented corners, determined from the adjusted measurement network,
2) The record bearings and distances to those monumented corners which will be different values from those derived from the measurement network,
3) A balancing algorithm prescribed by proper surveying methodology used to equitably distribute the difference between the record courses and the currently measured values.

Boundary Defining Flag – an attribute to a line that if set to true, means that the values are the official values that the line is to be known as. These values are to be used in annotating the lines and for use in computations such as Corner Restoration and Section Subdivision.

Closing distance. The distance in X and Y values from the Ending point coordinates, as determined from Record bearing and distance courses, to the Ending point coordinates determined by the currently adjusted measurement network

METHODS

Compass Rule (Bowditch Rule) Surveying Theory and Practice, Davis, Foote, Kelly, 1968, p 459
Also known as "Broken Boundary", Section 5-44 of 1973 Manual …, p.142.)

Transit Rule Surveying Theory and Practice, Davis, Foote, Kelly, 1968, p 459
Also known as "Grant Boundary" , Section 5-43 of 1973 Manual of Surveying Instructions, p.141.

Record bearing/distance.
Also known as "One (single) point control", Section 5-45 of 1973 Manual … , p.143.

Irregular Boundary. Section 5-36 of 1973 Manual of Surveying Instructions, p.137.

On a N-S line, the Y portion of the closing distance is distributed among the courses in proportion to the Y value of each course.

On an E-W line, the X portion of the closing distance is distributed among the courses in proportion to the X value of each course.

Double Proportion. Section 5-25 of 1973 Manual of Surveying Instructions, p.134.

The Y portion of the lost corner's coordinate is determined by the proportionate distance of the Y component between the controlling corners to the North and South, using the proportion derived from the cardinal equivalents of the record measurements. An adjustment is applied to put the lost corner along the latitudinal curve.

The X portion of the lost corner's coordinate is determined by the proportionate distance of the X component between the controlling corners to the East and West, using the proportion derived from the cardinal equivalents of the record measurements.

Single Proportion. Section 5-30 of 1973 Manual of Surveying Instructions, p.136.

The X and Y components of the restored corner's coordinates are derived by the record proportion that the lost corner has between the controlling corners. An adjustment is applied to put the lost corner along the latitudinal curve.

Three point control. Section 5-29 of 1973 Manual of Surveying Instructions, p.134.

If double proportionate method cannot be used because a line in one direction had never been established, then the cardinal component of the record distance between the lost corner and the corner opposite the unestablished corner is used to establish the appropriate X or Y value of the lost corner's coordinate position. An adjustment is applied to put the lost corner along the latitudinal curve.

Two point control. Section 5-29 of 1973 Manual of Surveying Instructions, p.135.

If double proportionate method cannot be used because a line to the North or South had never been established AND a line to the East or West had never been established, then:

The Y component of the record distance between the lost corner and the corner to the North or South is used to establish the Y value of the lost corner's coordinate position. An adjustment is applied to put the lost corner along the latitudinal curve.

The X component of the record distance between the lost corner and the corner to the East or West is used to establish the X value of the lost corner's coordinate position.

Crandall Rule (i.e. Stadia) Surveying Theory and Practice, Davis, Foote, Kelly, 1968, p 461

This procedure is applied where angles are far better than distances, a situation that is not true with current surveying tools that are used for boundary surveys. This procedure distributes the angular misclosure throughout the traverse, then uses a weighted least square analysis to adjust the distances. We believe that this is an obsolete method, but it merits mentioning in case users wish to add it later.

Arbitrary Method Elementary Surveying, Russell C. Brinker, 1969, p.228.

This method allows the arbitrary assignment of weightings or corrections "in accordance with the surveyor's analysis of prevailing field conditions". The thinking is that some areas of a project were more prone to slop so the surveyor disperses more correction into those areas, based on gut feeling. "This method of traverse adjustment is simple to perform and provides a logical assignment of weights based upon the expected accuracy of individual measurements."

It is hard to see how this could be implemented in NILS or whether this technique is valid for boundary surveys. We note it here because it is documented in a survey text and because some surveyors may be requesting this added flexibility.

Usage of Used_in_technical_adjustment_flag and Visibility_flag.

Refer to McKay's Core Data Elements for definitions. The Deleted_record_flag in Survey Management is measured data resulting from poor procedures or blunders.

Used_in_adj_flag	Visibility_flag	
On	On	Normal setting for boundary data
On	Off	Normal setting for ties and for coincident lines
Off	On	Displaying unadjusted data in context with adjusted data*
Off	Off	Archiving historical data that is obsolete for the network

The record data used in the corner restoration computations does not necessarily need to be part of the adjusted measurement network.

*Big note: If used_in_adj_flag is set OFF and visibility_flag is set ON, then override the following behavior rule: "Any point feature must be displayed in only one position." If the previous flag conditions exist, be able to plot a survey point in multiple places.

Corner Restoration Parameter Form

Restoration Method: ( ) Transit Rule ( ) Compass Rule ( ) Irregular Boundary (•) Double Proportion ( ) Single Proportion [ ] Multiple Selection Editor
( ) Record Bearing/Distance ( )Two point Control ( )Three Point Control

---

Datum Mode: [Projection] ↓ **Computation mode**: ( ) Geodetic (•)Plane **Elevation Units:** [feet] ↓

Beginning Point: [*Point Identifier*] [*x, y, z*] **Ending Point:** [*Point Identifier*] [*x, y, z*]

Data Selection and Results of Adjustment

Point Data	Record Data		Adjusted Data				Difference	
Point ID	Bearing	Distance	Bearing	Distance	Northing	Easting	Bearing	Distance

---

2nd Direction

Beginning Point: [*Point Identifier*] [*x, y, z*] **Ending Point:** [*Point Identifier*] [*x, y, z*]

Data Selection and Results of Adjustment

Point Data	Record Data		Adjusted Data				Difference	
Point ID	Bearing	Distance	Bearing	Distance	Northing	Easting	Bearing	Distance

Datum Display Mode: [*Projection*] ↓ **[Clear] [Back] [Next] [Save] [Cancel]**

Example of Junction Pop-Up Window

Next Available Station(s) Point ID	Bearing	Distance

Note: The Data Selection and Results of Adjustment form is automatically filled in, based on the input of the Beginning Point, Ending Point and the first To Point. The Junction Pop-UP Window opens during the process whenever a junction in a traverse is encountered. It allows a user to identify which traverse leg is to be used next. This occurs during manual input or if the system needs help during selection of features from the display.

MM 2.01 Identify least squares input data (Different sources, GPS, etc. Visual selection of data)

High Level Description	
Purpose	Identify data that will be used in the least squares analysis/adjustment
Actors	System user
Precondition	Data to adjust is available in graphic form and has proper attributes. Data is displayed in a common unit and datum.
Postcondition	Data to adjust is stored in a local repository where the least square analysis/adjustment expects it.
Description	User narrows display to the area needing adjustment and selects the area to adjust by a windowed box or other shape. The system organizes the windowed data in a structure and location expected by the least square analysis/adjustment.
Cross reference	Uses: Extends:
Development Implications and Considerations	
Data considerations	Selected data is converted to common datum and units for computation.
Requirements addressed	

Primary Scenario	
Actor Action	**System Response**
1. This use case begins when the user indicates a need to adjust an area of the measurement network.	2. User is given a spatial display and is prompted to select an area to adjust. [A selected data set exists.] Option to accept current data set.
3. User selects a box around the data or creates a polygonal “fence” around the data.	4. All lines and points within the selected area or crossing the selection line are organized for input into the least square process. The data is converted to common units and datum. All endpoints to lines crossing the selection line and outside the selected area are included in the data set as control points, but with a error estimate of 0.001, 0.001 (feet or meters). The measured values and their error estimates are organized into the following categories: Control points, Distances, Angles and Bearings. Another category is for approximate coordinates.

Footnotes:

This use case should be the place where all input control data is converted to a common coordinate system (datum/projection) and all line data converted to a common unit and type, as well as applying known corrections (2.05).

There is a performance issue here, the storage vs. possessing debate. When data is entered/modified it must be converted anyway in support of graphic display. It also must persist in its native units/format. If this data was stored also in the system’s unit and coordinate system then it would take up more room, but would be available directly to the least square engine. Another derivative and redundant data would be to

store the error estimates for control and bearings and the calculated error estimates for distance and angle with each piece of measurement. Error estimates must still be stored as attributes to the source data, for maintenance purposes.

If it seems quick enough to process this on the fly, every time a new dataset is identified for least square, then we should describe these functions in 2.01. Otherwise we should describe the process as occurring in the use cases where control, line and source data is imported or edited (3.01, 3.02, 3.04, 3.05, 3.06).

MM 2.02 Display unadjusted data in spatial view

High Level Description	
Purpose	See measurement data spatially in its unadjusted state.
Actors	System user
Precondition	Measurement data is complete enough that all lines can be connected to at least one point with a coordinate.
Postcondition	A display of the lines data, connected end on end without adjustment is available to the user and all control points are plotted in their unadjusted position.
Description	A blunder detection tool that displays line and point data in its raw form, without the effect of adjustments. With this display a user can ascertain where wrong measurement values exist and where wrong point identifiers were chosen.
Cross reference	Uses: Extends:
Development Implications and Considerations	
Data considerations	
Requirements addressed	

Primary Scenario	
Actor Action	**System Response**
1. This use case begins when the user selects the spatial view of unadjusted data option.	2. User is given a spatial display and is prompted to select an area to view. [selected data set exists] Option to accept current data set.
3. User selects a box around the data or creates a polygonal “fence” around the data.	4. A control point within the area is chosen arbitrarily and its coordinate value is used to derive all coordinates through line connectivity. All lines connected to the point are plotted and their endpoints added to the list of coordinates and so on until the endpoint coordinates of all lines are computed. [Some lines are not connected in the line network] Warn user if additional control is required and finds the control needed to include the unconnected lines. [If no control is found] Prompts for optional display of raw data. (Go to secondary scenario) System automatically refreshes display. Plot all lines on the display using the computed coordinates. Plot all control points using their unadjusted coordinate values. Label all endpoints and coordinate points. Use a special label font or highlighting or label suffix to identify the control point positions.

Secondary Scenario	
Actor Action	**System Response**
The user responds to prompt for display of raw data.	[Yes] Displays in a secondary window using arbitrarily system selected coordinates as a control point and notifies user. [No] Go to 4

MM 2.03 Display polygon misclosures graphically (values color-coded)

High Level Description	
Purpose	Calculates numeric polygon misclosure data for each polygon and displays each result within its polygon.
Actors	System user
Precondition	Line data is entered into some repository.
Postcondition	A graphic is displayed showing the lines and each closed figure has numeric values plotted within it showing misclosure data.
Description	A blunder detection tool and data analysis tool that displays the numeric polygon misclosure amount values and misclosing ratio values in each polygon. The values are color-coded or otherwise highlighted to bring attention to larger misclosure problems.
Cross reference	Uses: Extends:
Development Implications and Considerations	
Data considerations	
Requirements addressed	

Primary Scenario	
Actor Action	**System Response**
1. This use case begins when the user indicates a need to adjust an area of the measurement network.	2. User is given a spatial display and is prompted to select an area to adjust. [A selected data set exists.] Option to accept current data set.
3. User selects a box around the data or creates a polygonal “fence” around the data.	4. The bearings and distances of the lines within the selected area become the dataset for this process. All closed loops from this dataset are determined and the geometric closure amounts are computed and expressed as rectangular equivalents. An additional calculation is done to determine the misclosing ratio, which is the misclosing distance (polar) divided by the polygon perimeter. Also compute a worst-case closure for each polygon by accumulating an error based on the error estimates for the bearings and distances, then dividing the misclosing polar distance by the accumulated polar distance. The name of this result could be called the error comparison value. The user is given display format options: rectangular equivalents, closing ratio, or both. [default option exists] Show misclosures with the default option.
5. User selects option if not the default.	6. Display the data in the format chosen. Color-code or otherwise highlight the numeric text based on the error comparison value.

MM 2.04 Apply known corrections to distance measurements

High Level Description	
Purpose	Apply known corrections to distance measurements to optimize adjustment results.
Actors	System
Precondition	Measurement data is available and the correction for distances for a source of data is available.
Postcondition	The distances available for the least square process have been adjusted for known corrections.
Description	Known distance corrections are stored as attribute data to a data source. The measured distance value is adjusted based on known distance corrections. The least squares process always uses the adjusted distances in its analysis.
Cross reference	Uses: Extends: 2.01, 2.02, 2.03, 3.06
Development Implications and Considerations	
Data considerations	
Requirements addressed	

Primary Scenario	
Actor Action	**System Response**
1. This use case begins from a trigger actuated when the distance measurement has been converted to a common unit.	2. Two distance corrections are read from the attributes of the source of the data: the constant correction and the variable correction. If these values are both either zero or null, then no correction is needed. The variable correction is multiplied with the distance value. This result and the constant correction are added to the distance value and stored as the corrected distance. [Corrections may have negative values.] Do not use absolute values when adding.

MM 2.05 Apply known corrections to direction measurements

High Level Description	
Purpose	Apply known corrections to direction measurements to optimize adjustment results.
Actors	System
Precondition	Measurement data is available and the correction for directions for a source of data is available.
Postcondition	The directions available for the least square process have been adjusted for known direction corrections.
Description	Known direction corrections are stored as attribute data to a data source. The measured direction value is adjusted based on known corrections. The least squares process always uses the adjusted directions in its analysis.
Cross reference	Uses: Extends: 2.01, 2.02, 2.03, 3.06
Development Implications and Considerations	
Data considerations	
Requirements addressed	

Primary Scenario	
Actor Action	**System Response**
1. This use case begins from a trigger actuated when the direction measurement has been converted to a common unit.	The direction correction is read from the attributes of the source of the data. If this value is zero or null, then no correction is needed. The correction is added to the direction value and stored as the corrected direction. Correction may have a negative value. Do not use absolute value when adding.

MM 2.06 Create approximate coordinate value for each line endpoint

High Level Description	
Purpose	Provide best approximate coordinate values for all line endpoints in the data set in preparation for the least squares process.
Actors	System
Precondition	Measurement data for lines exist and at least one control point exists for each network of lines. An initial coordinate value will exist for each point to support graphic display of input data, but is not optimized for use in the least squares process.
Postcondition	All line endpoints have their most valid coordinate values, based on existing data.
Description	Coordinate values are generated that most closely approximate the value that will be generated by the least squares process. The coordinates are generated by compass rule adjustments between control points, through line paths, until all the endpoint coordinates are generated. The better the approximation, the easier the load is on the least squares process.
Cross reference	Uses: Extends: 2.04, 2.05, 2.07 or 3.06
Development Implications and Considerations	
Data considerations	
Requirements addressed	

Primary Scenario	
Actor Action	**System Response**
1. This use case begins automatically by triggers in any of a number of places, to be determined by performance[1]. Suggestions: a. Compute optimized approximations on the fly, during Use Case 3.06. b. Compute optimized approximations when user invokes another process other than data entry/edit (Use Case 3.06). c. Compute optimized approximations when user invokes least squares process (Use Case 2.07). Suggestion **a.** would result in the worst optimization of coordinate values unless reoptimization is performed on the entire data set for each new adjustment. Assume complete reoptimization is required in **a**. Suggestion **c** is probably the best in that it need only be run once per adjustment, where **b** would be run repeatedly per adjustment, with only the final adjustment being relevant. Exception: if run repeatedly via **b**, the optimal coordinates would be available to other processes.	2. Endpoint coordinates will always be generated throughout data entry of lines, in support of graphic display. When this use case is triggered, all coordinates in the dataset are re-generated using the following strategy: -Place control points in the data set in a temporary control point list, ranking points based on error estimate values. -Place lines in the data set into a temporary lines list, ranking lines based on error estimate values. -Calculate coordinates of non-control points by a succession of paths through the data set like: --Beginning with a control point with a high quality (lowest error estimate value), find a path to another high quality control point through lines of highest quality. --Determine the misclosure of the path. --Perform a compass rule adjustment to determine the endpoint coordinates along the path and add these points to the list of new points to process. --Find the center point of the path by length --Establish the "x,y error estimate" for this point by averaging the error estimates of the control points at either end of the path and adding the polar distance component of the path's misclosure each of the x and y error estimate values.

	--Determine the error estimates for each of the new points by: --- determining the proportionate distance, along the path: distance from the closest control point to the new point divided by the distance from the closest control point to the center point ---applying that proportion to the change of error values between the closest control point and the center point, to derive an intermediate value ---adding the intermediate value to the error estimate of the control point ---finally, adding the new points with coordinates and "error estimates" to the temporary control point list in their proper ranking based on "error estimate" values. --When finished with a path, remove that path's lines from the temporary list of lines to be processed. -Continue processing lines until all points are computed. -Place computed coordinate values where they can be accessed by the least squares process.

Secondary Scenario	
Actor Action	**System Response**
Raw data island found, during approximate coordinate generation.	Flags those lines of raw data for coordinate generation and least squares adjustment.

[1] In GMM this process is triggered when the user leaves the data entry/editing executable INRAW. There is a standalone executable call GEN that accomplishes the same thing and also creates a report file showing closures of section exteriors. The alternate standalone GENER behaves like GEN, but instead of limiting itself to section line closures initially, it applies closures between control points and achieves better coordinate values.

MM 2.07 Adjust measurement network with least square analysis process

High Level Description	
Purpose	Perform an iterative parametric least squares analysis/adjustment of the measurement network to derive the best coordinate values possible.
Actors	System user
Precondition	Optimal approximate coordinates for all points in the data set exist (use case 2.06) and measurement data is organized and available (use case 2.01).
Postcondition	Final coordinates are entered into the database with proper attribution.
Description	A measurement data set of control point coordinates, bearings, angles and distances is analyzed utilizing error estimates and the initial set of approximate coordinates is adjusted to achieve the most likely coordinate values possible for the data set. The coordinates are stored in a data repository along with data pointing to the who/what/when of the adjustment.
Cross reference	Uses: 2.01, 2.04, 2.05, 2.06 Extends: 2.08
Development Implications and Considerations	
Data considerations	
Requirements addressed	

Primary Scenario	
Actor Action	**System Response**
1. This use case begins when the user chooses to perform the least squares process.	2. The least squares process reads the measurement values, error estimates and approximate point coordinates. The adjustment parameters are determined, specifying whether robusting is turned on, whether to adjust with a single point of control (unconstrained adjustment), the amount of residual tolerance, the iteration limit value and statistical reporting formats[1].
	3. The iterations are performed until the improvement in coordinates is less than the residual amount or if the iteration limit is reached. After, each iteration a report on the statistics is output unless the statistical reporting format[1] specifies no report.
	4. After the final iteration the statistics of the overall adjustment are computed as follows: The residuals (and optionally the snoop numbers of each measurement) are associated with each measurement. The SEUW, the measurements receiving the most adjustments and the measurements with the highest snoop number are reported. Also, if an adjustment reached the iteration limit without reaching the residual tolerance, then an unmistakable error message is given to the user.
	5. The user is given options for the next action. [View detailed report of adjustments in spreadsheet format] Execute use case 2.08.2.

	[View "snoop" values in spatial format] Execute use cas 2.08.3. [Run snooper option] Execute use case 2.08.3. [Adjust robusting options] Execute use case 2.08.4. [Continue adjusting] This option is chosen if the iteration limit is reached and the user believes that more iterations will achieve a successful result or may achieve a higher quality result. This could be achieved by letting the user modify the iteration limit in the analyze/adjust parameter form (See 2.08.6). The adjustment would continue adjusting with the results of the current adjustment and continuing the iteration counter value from where it was previously set. [Compare to another adjustment] Execute use case 2.08.7. [Name the adjustment] This option is only valid for constrained and successful adjustments (reached residual tolerance). This option saves the coordinates, attributes[2] and residuals into a "final" (published, enterprise) database. The results of a robusted and/or constrained adjustment can be named, but some flag (adjustment_type[2]) should be set to prevent this data from entering any "final" database. This option also triggers the option to compute and store error ellipses, use case 2.08.1. [Cancel]

[1]statistical reporting formats (this would be a useful interface, postpone to rev 2?):

On the Analyze/Adjust Parameter Form there could be the following option: "Track Standard Error of Unit Weight (SEUW) after each iteration: A) Enable tracking [1a) textually 2a) line graph charts] and B) Disable tracking". With large datasets it is informative to track certain values through the iterations.

Explanation: Iterations happen in the blink of an eye with smaller datasets, but the combined information from all the iterations the adjustment is still informative. The line graph chart would have SEUW expressed as a Y value, with a logarithmic scale with 0.2 at the bottom. Elapsed time would be expressed as an X value on a linear scale. The chart would have a pre-set height and length, probably about 4 times longer than its height. After the first iteration, the range of values is determined for the scales. The height of the scale should be about 110-125% of the SEUW value. The 110-125% of the predicted time of completion would become the X value at the right side of the graph. A reference line for SEUW, perhaps a dotted line would be plotted at the 1.0 height. The SEUW value from the first iteration would be plotted as a point on the graph, labeled with the SEUW value. Subsequent SEUW values would be plotted/labeled with a line connecting. The table size or reference scales may need recomputing if either the SEUW or elapsed time exceed the predetermined values.

A similar chart could be formed for reporting the most-adjusted distance residual from the iteration or the highest distance snoop value. Additional charts could be formed for control, angle and direction.

[2]Table for adjustment from my core data work, but with local variations in blue. It is possible that I will incorporate these variations into the core data.

```
CREATE TABLE ADJUSTMENT_ATTS
   ( Adjustment_dataset      VARCHAR2(16)              ,
     Adjustment_type         VARCHAR2(10)              ,
     Adjustment_date         DATE                      ,
     Adjusting_agent         VARCHAR2(30)              ,
     Std_Err_Unit_Wt         FLOAT(12)                 ,
     Residual_limit          FLOAT(5)                  ,
     Iteration_limit         INTEGER(2)                ,
     Rel_buffer_dist         INTEGER(2)                ,
     Software_used           VARCHAR2(20)              )
     STORAGE ( INITIAL 100K        NEXT 50K
     MAXEXTENTS 10       PCTINCREASE 5
     FREELIST GROUPS 7   FREELISTS 4 )         ;
```

MM 2.08.1 Option: compute error ellipses

High Level Description	
Purpose	Compute error ellipses for all adjusted coordinates in the data set.
Actors	System user
Precondition	Least Squares process has been successfully executed, unconstrained and without robusting. Coordinates, unadjusted measurement values and Standard Error of Unit Weight of adjustment are available.
Postcondition	Error ellipses for each point have been determined and database has been updated.
Description	After a successful least squares adjustment/analysis has been performed to determine the best coordinate values, an extra analysis is run to determine the ellipse around each point the defines the boundary within which a 95% chance that the true value exists. The ellipse is described by its semi-major and semi-minor axis and the angle from north to the direction of maximum error. This ellipse data is essential data for the published database.
Cross reference	Uses: 2.07 Extends: 2.07
Development Implications and Considerations	
Data considerations	
Requirements addressed	

Primary Scenario	
Actor Action	**System Response**
1. This use case begins a) when the user chooses the “compute error ellipse” option and/or b) automatically from “save named adjustment” option described in use case 2.07. How this is handled is a user interface issue.	2. Data from the analyze/adjust parameter form is read in to set the proper buffer distance. [Overall data set is very large] A routine could be executed that would break the data set into smaller blocks, and process each of the blocks until the entire data set is complete. Depending on performance, it could be optimal to develop a small data set for each point, consisting of measurement data within the buffer distance of the point.
	3. The measurement data from the adjustment is read in as well as all measurement data within the buffer data. The SEUW value from the adjustment is read. The mathematical process calculates the error ellipses for each point and stores them as attributes to the point. The buffer distance is stored as an attribute to the named adjustment.

MM 2.08.2 Option: display statistical results in tabular form

High Level Description	
Purpose	Display the statistical results of the adjustment in tabular form.
Actors	System user, most likely a Surveyor or someone acting in the capacity of a surveyor.
Precondition	The least squares process has been run.
Postcondition	The requested statistics have been generated and displayed in a tabular format to the user.
Description	For blunder detection and data analysis it is helpful to see the exact statistics of the adjustment in a tabular form. This applies to the results of each measurement as well as the statistics derived from the adjustment as a whole, i.e. SEUW.
Cross reference	Uses: Extends: 2.07
Development Implications and Considerations	
Data considerations	
Requirements addressed	

Primary Scenario	
Actor Action	**System Response**
1. This use case begins when the user chooses the option to view statistics of the adjustment in tabular form.	2. The measurement data is read, the *Analyze/Adjust Parameter Form* is read to determined reporting content, the error estimates are read, the residuals are read and the snoop values are computed. The Standard Error of Unit Weight is read or computed. These values are displayed in tabular form[1]. The default order of measurements is the order in which they were entered into the system. (would this be called Measured_line_ID?)
3. [User changes parameters on the *Analyze/Adjust Parameter Form*] Go to Step 2. The pertinent parameters here are the: Residual Report Limit, used to only report data where the residual value is higher than the specified limit. Snoop Report Limit, used to only report data where the snoop value is higher than the specified limit. Sort by Snoop value, default is descending downward by value. Sort by Residual value, default is descending downward by value.	4. **[Save]** User is given a chance to name the report file. The default is the name of the adjustment. **[Cancel]**

Footnotes:
[1]See GMM's .ADJ file for an example of tabular format.

This tabular format allows the user to navigate through the data and see exact residual values, snoop values, error ellipses and measurement values for each measurement. It is also useful to see the overall statistical rating of the adjustment, the Standard Error Unit Weight (SEUW), as well as being able to locate the distance that adjusted the most or had the highest snoop number. The same holds true for angles, directions and control points.

Additional fields such as the Source_ID and the Source_ID_qualifier would greatly assist the user in understanding the data in the report. The .ADJ file does not have this.

MM 2.08.3 Option: display "snoop" values in spatial view

High Level Description	
Purpose	Display snoop values through symbology and highlighting of the spatial display of the measurement network.
Actors	System user, most likely a Surveyor or someone acting in the capacity of a surveyor.
Precondition	Least square process has been run and measurement data for that data set is available.
Postcondition	A graphic of the adjusted area is displayed and the snoop values for the lines and control points are symbolized in some way to reflect the snoop value(s) of each measurement.
Description	In order to find blunders and to analyze the quality of data, it is useful to have “snoop” numbers, which represent how many times more did an item adjust than what was expected. Having a spatial view of these features with the snoop values symbolized in some intuitive way helps the user to see problem areas and to see patterns in data. This leads to easier maintenance by either fixing blunders or by redefining the quality of the data.
Cross reference	Uses: Extends: 2.07
Development Implications and Considerations	
Data considerations	
Requirements addressed	

Primary Scenario	
Actor Action	**System Response**
1. This use case begins when the user chooses an option to view the snoop numbers in a spatial format.	2. The residuals from the least square process are read well as the error estimates for each of the measurement The residual divided by the error estimate results in the “snoop” number. (A value of 1.0 is optimal.)
	3. The snoop value found in the equivalent to the GMM’s .ADJ file is used to highlight lines by color-ramping or with line width or line type. Each line will have one snoop value for distance and one for direction, so user will have to toggle between displays or system could present both data simultaneously by using creative symbology. Control points can be symbolized to show what direction they moved and can express their snoop value through color-ramping or by symbol size or shape

Footnotes:

Snoop Value = Residual / Error Estimate

MM 2.08.4 Option: apply robusting using adjusted data

High Level Description	
Purpose	Apply robusting to further analyze a data set with the least squares process.
Actors	System user, most likely a Surveyor or someone acting in the capacity of a surveyor.
Precondition	The least square process has been run, the robusting parameters are set in the Analyze/Adjust Parameter form, and the robusting option has been enabled.
Postcondition	The adjusted data has been readjusted with a different weighting design to narrow the adjustments to the areas where the misclosures are greatest. A flag is set indicating that the readjusted data set was robusted, preventing it from being integrated into the enterprise database.
Description	Robusting is a blunder analysis tool that locates the area of a blunder by adjusting the weighting. The error estimates are modified to be greater for measurements with the higher residuals in the previous adjustments so that successive iterations will narrow the adjustment to be exaggerated where the blunder occurred, rather than smoothed out as in non-robusted adjustments. The user has control over the amount of robusting to be applied and to what kind of measurement (control, distance, angle, direction). It is up to the user to interpret the results and to examine the measured data for blunders or to readjust error estimates to reflect poor quality data.
Cross reference	Uses: 2.07 Extends:
Development Implications and Considerations	
Data considerations	
Requirements addressed	

Primary Scenario	
Actor Action	**System Response**
1. The use case begins when a least square process begins readjusting a data set and the robusting option is enabled.	2. The robusting parameters are read and the error estimates of the data set are adjusted according to the user's wishes.
	3. This process would then call the least square adjustment process (use case 2.07) which relies on the error estimates in its weighting. A flag would be set to indicate that adjustment was robusted, preventing the data from being integrated into an enterprise data base. This could be the attribute Adjustment_Type in the Adjustment data table (see core data elements footnote in use case 2.07).

MM 2.08.5 Option: perform adjustment with single control point

High Level Description	
Purpose	Perform a least square adjustment using only one point as the basis of the coordinate system (“unconstrained”).
Actors	System user, one who has expertise in analyzing survey data.
Precondition	The data set of lines is complete and all points have approximate coordinates.
Postcondition	The data set of lines is adjusted without influence of redundancy provided by control points. A flag is set is set indicating that the readjusted data set was unconstrained, preventing it from being integrated into an enterprise data base.
Description	For blunder detection mainly and for data quality analysis it is helpful to adjust the lines on their own merit without influence from the control points. This simple adjustment can point out data entry blunders in bearings and distances and point out misnamed point IDs. The user checks some box or radio button in the Analyze/Adjust Parameter form to toggle this feature on or off.
Cross reference	Uses: 2.07 Extends:
Development Implications and Considerations	
Data considerations	
Requirements addressed	

Primary Scenario	
Actor Action	**System Response**
1. This use case begins when the user chooses to use the least square process and the single-point control option is enabled in the Adjust/Analyze Parameter form.	2. Any control point in the data set is arbitrarily chosen to occupy the required spot in the control point measurement section. All line data and all approximate coordinates are read into the least square process.
	3. The least square process is run and the usual results are displayed to the user. A flag would be set to indicate that the adjustment was unconstrained, preventing the data from being integrated into the enterprise data base. This could be the attribute Adjustment_Type in the Adjustment data table (see core data elements footnote in use case 2.07).

MM 2.08.6 Option: edit robusting parameters

High Level Description	
Purpose	Edit robusting parameters to elicit different adjustment results.
Actors	System user with ability to analyze measurement data.
Precondition	Adjustment parameter form is accessible.
Postcondition	The robusting parameter field entry portion of the *Adjust/Analyze Parameter Form* has been edited.
Description	Robusting can be applied to control points, distances, angles, bearings or any combination. In order for the user to explore different aspects of the data, the user must be able to specify how the adjustment is going to be performed. The options are made available on the *Analyze/Adjust Parameter Form*.
Cross reference	Uses: Extends: 2.07
Development Implications and Considerations	
Data considerations	
Requirements addressed	

Primary Scenario	
Actor Action	**System Response**
1. The use case begins when the user modifies the robusting portion of the *Analyze/Adjust Parameter Form*.	2. The *Analyze/Adjust Parameter Form* is updated to reflect the user's choices. [User unchecks all boxes] Robusting is disabled.

MM 2.08.7 Option: report coordinate differences between adjustment scenarios

High Level Description	
Purpose	Report coordinate differences between two least square adjustments of the same points.
Actors	System user
Precondition	An least square adjustment has been run and there is another named adjustment of the same points that is available for comparison.
Postcondition	A report is provided to the user with a comparison of coordinate shifts of points within two sets of adjustment scenarios.
Description	An indication of data quality can be ascertained by comparing the data's behavior under differing constraints in the least square process. Factors such as weighting, robusting, single-point control as well as inclusion or exclusion of certain pieces or sources of data will provide different coordinate values. A trained user can use these results to develop more insight into how the data best integrates and how to assign reasonable error estimates.
Cross reference	Uses: Extends:
Development Implications and Considerations	
Data considerations	
Requirements addressed	

Primary Scenario	
Actor Action	**System Response**
1. This case begins when the user chooses the compare adjustments option.	2. User is given choice of named data sets to choose from.
3. User selects the data sets to compare.	4. Both coordinate sets are read and all matches by point ID are identified. The difference of coordinates is tabulated and presented to the user. The default order of points is by point ID value. The default sort order is descending in value. The default tolerance for display is initially zero (all results are displayed), however a persistent value should be stored in a user or organization's profile during initial configuration. The user is given alternate ways in viewing the data. [Sort results by polar distance shift] Go to 3. [Sort results by x distance shift] Go to 3. [Sort results by y distance shift] Go to 3. [Toggle ascending/descending sort] Go to 7. [Show only major shifts] Go to 9. [Show shifts in spatial view] Go to 11.
5. User pick alternate sort order.	6. Redisplay results with chosen option.

7. User chooses to reverse sort order.	8. Redisplay results in reverse order.
9. User sets tolerance limit on displayable results.	10. Redisplay only those results that exceed the shift tolerance chosen by user.
11. User selects a spatial view of the shifts and maybe some parameters such as symbology.	12. A spatial view of the measurement network is presented as a backdrop with the shifts of the points highlighted. The shifts would be symbolized through size and/or color to indicate the amount of polar shift amount or the rectangular components of the shift.
	13. User has exit options. **[Save as]** Saves report to user-named file. Option to save spatial view as an image file. **[Cancel]**

Footnotes:

GMM program COMPARW.EXE accomplishes this task with a pre-defined tabular format.

MM 3.01 Import GCDB data

High Level Description	
Purpose	Import GCDB data for use in the measurement network.
Actors	Surveyor
Precondition	GCDB data exists and measurement network is accessible.
Postcondition	GCDB data is incorporated into the measurement network.
Description	GCDB data is imported and incorporated into the measurement network. GCDB data can be in existing GCDB coverage format or can be in raw GMM file format.
Cross reference	Uses: Extends:
Development Implications and Considerations	
Data considerations	
Requirements addressed	

Primary Scenario	
Actor Action	**System Response**
1. Begins when user selects Import GCDB data.	2. The system provides the ability to browse for the data location of GCDB data. Prompts for GCDB data types to import, i.e. the GMM con, raw, sid, add, etc. or ALL or coverage.
3. User selects data type and browses to the data set(s) to be imported.	4. Makes necessary conversions to put data in standard formats and imports data to the measurement network.

Secondary Scenario	
Actor Action	**System Response**
GCDB data does not exist.	Warns user and prompt for location of GCDB data.

MM 3.02 Import Non Measurement Management Control data

High Level Description	
Purpose	Import non-measurement management control data for use by measurement management.
Actors	Surveyor
Precondition	Control data exists.
Postcondition	Non-measurement management control data is formatted for use in the measurement management environment.
Description	Import non-measurement management control data for use in the measurement network. This control data can be in different formats from various sources (dxf, xy, lat long etc.).
Cross reference	Uses: Extends: 1.01 through 1.12, 2.01
Development Implications and Considerations	There are numerous file formats. (need list)
Data considerations	There are numerous file formats. (need list)
Requirements addressed	

Primary Scenario	
Actor Action	**System Response**
1. Begins when user selects Import Non MM control data.	2. The system provides the ability to browse for the data location of non-MM control data. Assists the user in importing data through import wizard i.e. setting up columns and file formatting, or using standard formats or templates.
3. User uses wizard to format non MM control data for use in MM.	4. Makes necessary conversions to put data in standard MM formats for use in Measurement Management. Overlay new control points onto existing coverage. With each new control point, snap to the nearest old point, but only if the new point is within the error ellipse of the old point. By snapping, only extract the point ID of the old point and apply it to the new point. After processing the points with no ambiguity, start presenting the user with decisions as follows: [new point does not fall within the error ellipses of existing old points] Present user with opportunity to enter the new point's ID, with option to pick existing point from screen as form of entry. Go to 5. [new point falls within the error ellipses of multiple points] Present user with opportunity to enter the new point's ID, with option to pick existing point from screen as form of entry. The multiple points are highlighted in this option and a list of point IDs of the highlighted points are presented to the user. Go to 5. [new point matches exactly in coordinate value with existing old point] Present user with metadata of both the old and new points and ask if the new data should

	add to or replace the old data or cancel the new. [Cancel] [Save]
5. User chooses the correct ID from the list or the screen or types ID into the field entry box. Highlight all new points with a symbol/color that identifies it as - ID assigned automatically - ID not found or too ambiguous - ID selected by user Often comments are included as descriptions of the point. These descriptions should be made available as a popup or at bottom of screen if user puts cursor over symbol or its entry on a list. User can also drag the old point (or point ID text) from the old position and drop it on the symbol of the new control point. Highlight the moved symbol to show it is done. User may cancel or save.	6. System processes input as appropriate.

Footnotes:

This use case does not address the problem of assigning the correct point IDs to the control being brought in. This control either has no IDs or rule-based IDs peculiar to the data's source.

MM 3.03 Display measurement data in spatial format

High Level Description	
Purpose	View measurement data spatially during data entry of measurements.
Actors	System user
Precondition	At least one arbitrary, but temporary control point to allow display of lines as they are entered. Recorded measurement data is available for data entry.
Postcondition	A display of the lines data, connected end on end is available to the user. Points and all control points are displayed.
Description	A sketch of data, as it is being entered, is displayed spatially. When there is enough data entered for the system to generate a view of lines and/or control points then all of the data is displayed together in main view.
Cross reference	Uses: 2.06. Extends: 3.05, 3.06
Development Implications and Considerations	
Data considerations	
Requirements addressed	

Primary Scenario	
Actor Action	**System Response**
1. This use case begins when the user selects spatial view of measured data option, during data entry operations.	2. User is prompted for existing or new data.
3. User responds to prompt.	4. [data exists] User is prompted for location of data and presented with a spatial display of selected data. Go to 5. [no existing data selected] Open sketch window for display of data as it is entered. Go to 6.
5. Select point to begin data entry from, either manually or from display.	6. [data exists] As data is entered, the main display is updated to include the new data. All the points are displayed and their endpoints added to the list of coordinates and so on until the endpoint coordinates of all lines are computed. NOTE: Naturally, all measurement data will be converted from their native units/formats/datum/projections into a consistent system environment. All known corrections would be applied at this point (2.05). See "2.06. Create approximate coordinate value for each line endpoint". Approximate coordinates for least squares adjustment are generated on the fly. NOTE: These are pre-least squares adjustment coordinates. Go to 12. [data entered is unconnected] User is presented with a sketch graphics window for unconnected data. An arbitrary coordinate value within the sketch view is assigned to the first point and this coordinate value is used to derive all coordinates through line

	connectivity. Connectivity is determined by point Ids entered during data input. There can be multiple sketch windows open for a project. When a new Point Id matches an existing one the display is updated by closing the new data window and displaying it as connected with the existing data in a single sketch window or the main view if possible. NOTE: The "existing" data can be either "pre-existing" (as in it comes from a selected data set) or it may be on another unconnected line of the same project that was previously entered but not integrated with any other data set. Provides option to toggle display on and off for each active sketch window, or move through each window with [back] and [forward] devices. Go to 12. [no existing data selected] A control point within a sketch view is chosen arbitrarily and its coordinate value is used to derive all coordinates through line connectivity. As data is added, the sketch display is updated to include the new data. All the points are displayed and their endpoints added to the list of coordinates and so on until the endpoint coordinates of all lines are computed. Provide option to integrate new data with existing and prompts for location of the existing data to integrate with new data. Go to 7. [option to integrate is unmarked] Go to 12.
7. Responds to prompt	8. Displays selected existing data in a new graphics window. At least one sketch window remains open.
9. Selects points to begin integration of new data with existing data. One from the new data sketch window and a corresponding one from the existing data window.	10. Integrates the data sets. Prompts to accept integration.
11. Responds to prompt	12. Plot all lines to the main display using the computed coordinates. Plot all control points using their coordinate values. Label all endpoints and coordinate points. Use a special label font or highlighting or label suffix to identify the control point positions.

Secondary Scenario	
Actor Action	**System Response**
Point Ids of selected endpoints do not match.	Warns user and provides choices for Point ID to use.
Line A-C hidden by lines A-B and B-C. User wants to see where this occurs.	When requested by user, highlight lines within tolerance of other lines. (Coincident lines.)

MM 3.04 Display/edit source-level data in spreadsheet format

High Level Description	
Purpose	To allow for the review of source-level data in an easily edited format. May optionally input new data.
Actors	Surveyor
Precondition	Need to review or edit source-level data and links with line data. Measurement data is displayed graphically so user may select the desired data set to be used. Existing source-level data is available for the data set to be reviewed or edited.
Postcondition	Source-level data is presented to user for review and editing. Edited data is updated and stored locally.
Description	Allows for the review and editing of existing source-level data for a selected data set. Optionally allows for input of new source-level data and links with selected line data.
Cross reference	Uses: Extends:
Development Implications and Considerations	
Data considerations	
Requirements addressed	

Primary Scenario	
Actor Action	**System Response**
1. Begins when user selects to review/edit the source-level data.	2. Presents a spreadsheet of the source-level data for all lines displayed within the graphics window. Only full lines being displayed are presented in the spreadsheet. Present option to link source-level data to line data.
3. User selects lines from the graphic display for the desired source-level data to review/edit. User should also be able to toggle off lines to remove them from selection.	4. As user selects lines they are highlighted both graphically and in the spreadsheet.
5. User reviews/edits source-level data as needed. Editing includes ability to link selected source-level data to user selected lines when user marks option for it.	6. Assists user in editing spreadsheet by jumping to next appropriate field as each field is completed. Updates graphics display as changes are made in the spreadsheet. [link source-level data to raw data line] Assist user in selecting raw data lines to link with a selected source-level data set. Prompt to save changes.
7. User selects appropriate action button.	8. **[Save]** Saves changes and closes the source-level data spreadsheet. **[Cancel]** Exits without saving changes and closes the source-level data spreadsheet.

Secondary Scenario	
Actor Action	**System Response**
No source-level data is available.	Warn user and prompt for location of existing source-level data. Presents blank source-level data spreadsheet when no data is being displayed graphically and user begins use case. Assists user in filling in spreadsheet by jumping to next appropriate field as each field is completed.
Need to link existing source-level data with existing line data.	Presents source-level data available for line data in graphics window. Assist user in selecting lines to link with a selected source-level data set.
No line data is available.	Warn user and prompt for location of line data. Assist user in selecting lines to link with a selected source-level data set.
Select lines needing global change in value(s).	Highlights lines and provide display for user to fill in the field(s) with values to globally change in selection.
Select lines needing global change proportionally, as in increasing the bearing error estimates for all sources except one.	Highlight selected lines and let user fill in fields with multipliers. This could be the same as above scenario, except "150%" in the field would trigger a proportional increase rather that assumption of 150 seconds.
User selects to display Record Line Data w/ Source Data.	Displays Source Data for each line of Record Line Data in spreadsheet format.

Footnotes:

I thought it would be useful to be more detailed about the "Conversion Options" found in MM_samples.xls, Source data page. I might note that the heading "angular error (secs)" should read "direction error(secs)".

This is metadata and attribute data about source-level data. See Source Attributes table in my Core Data Elements ERD. These are described in the document coredata_fgdc.def.doc and listed below with comments.

Source_ID – Used with Source_ID_qualifier to identify "Source Document"
Source_ID_qualifier (user-defined subset of source) – for management of estimates.
Source_document_title - official name of document, optional
Survey_Agent - Surveyor
Survey_date – Approval date.
Measured_coordinate__horizontal_datum_name – Example: NAD27
Measured_coordinate__coordinate_system_definition – Example: Lat/Long
Measured_coordinate__projection_unit - Examples: International feet, meters
Measured_coordinate__vertical_datum_name – Example: NAVD29
Measured_coordinate__error_estimate – Example: 0.5
Measured_coordinate__error_estimate_units – Examples: Survey feet, meters
Measurements-are-recorded-values-or-derived-from-scan-of-survey-plat_flag – Y/N
Measured_line_straight-or-geodetic_flag – Straight, geodetic (rhumb line)
Distance_unit - Examples: Survey Feet, Intl. Feet, meters, chains, varas, poles, perches
Distance_type – Examples: ground, ellipsoid, plane/grid
Distance_correction_constant – Can be positive or negative value, use system unit.
Distance_correction_ppm - Can be positive or negative value, use system unit.
Distance_error_estimate_constant – This forms part of the estimate for each distance
Distance_error_estimate_ppm – Multiply this proportion with distance and add to constant, above.
Direction_quadrant – (Direction_reference): NE, SE, SW, NW, and CN or RN (azimuth rt from N)
Direction_unit – Ex: radians, grads, decimal degrees(DDD.ddd), DDD-MM.mm, DDD-MM-SS.s
Direction_type – Examples: mean, forward, grid, compass, unknown.

Direction_correction - Can be positive or negative value, use system unit.
Direction_error_estimate – This value is associated with every bearing/azimuth from this source of data.
Measured_angle_unit – Same as Direction_unit.
Measured_angle_error_estimate – Same as Direction_error_estimate. Non-null value associated with a survey is flag to compute angles from adjacent lines within the survey and add to the Least Square Adjustment of the measurement network.

Source Data Spreadsheet

Project	Source ID	Constant error estimat	Distance error estimate	Angular error estimate (seconds)	Agency Code	Date of Approval	Typ	Surveyor	Distance Systematic Error Correction			
									Native Units	Datum Type	Constant +/-	ppm Correctio
21T01600NR0070V	5RS72VB	0.1	250	20	CA011	15-Sep-1995	D	OMSBERG.K.J. JR. LS4446	F	G	0.05	0.0
21T01600NR0070V	1995NB	0.1	200	20	BLM	17-Dec-1996	D	COOK,F.V. LS3966				
21T01600NR0070V	1995NB-TIE	0.1	200	20	BLM	17-Dec-1996	D	COOK,F.V. LS3966				
21T01600NR0070V	1987VB	0.1	250	20	BLM	12-May-1992	D	SEVY,M.L.				
21T01600NR0070V	1986	0.1	300	60	BLM	14-Feb-1989	D	NELSON,D.E.; SCHMITT,J.V.				
21T01600NR0070V	1986EB	0.1	300	60	BLM	14-Feb-1989	D	NELSON,D.E.; SCHMITT,J.V.				
21T01600NR0070V	1986NBA	0.1	500	240	BLM	14-Feb-1989	D	NELSON,D.E.; SCHMITT,J.V.				
21T01600NR0070V	1986NB	0.1	250	4500	BLM	14-Feb-1989	D	NELSON,D.E.; SCHMITT,J.V.				
21T01600NR0070V	1986-TIE	0.1	300	60	BLM	14-Feb-1989	D	NELSON,D.E.; SCHMITT,J.V.				
21T01600NR0070V	1986A-TIE	0.1	2000	90	BLM	14-Feb-1989	D	NELSON,D.E.; SCHMITT,J.V.				
21T01600NR0070V	1986VB	0.1	200	20	BLM	14-Feb-1989	D	NELSON,D.E.; SCHMITT,J.V.				
21T01600NR0070V	1884SB	0.1	200000	1800	GLO	17-NOV-1884	B	WOODS,J.E.				
21T01600NR0070V	1880	0.1	200000	28800	GLO	18-AUG-1880	O	WOODS,J.E.				
21T01600NR0070V	1880NB	0.1	70000	360	GLO	18-AUG-1880	O	WOODS,J.E.				
21T01600NR0070V	1880A	0.1	700000	14400	GLO	18-AUG-1880	O	WOODS,J.E.				
21T01600NR0070V	1880B	0.1	2000	14400	GLO	18-AUG-1880	O	WOODS,J.E.				
21T01600NR0070V	1880VB	0.1	500000	3000	GLO	18-AUG-1880	O	WOODS,J.E.				
21T01600NR0070V	1871SB	0.1	50000	5400	GLO	27-Sep-1871	O	CHAPMAN,I.N.				
21T01600NR0080V	USFS1997VB	0.1	300	30	USFS	??-???-1999	D	W.C. Nowlin				
21T01600NR0080V	1997SB	0.1	600	2700	BLM	1-May-98	D	J.F. Carroll				
21T01600NR0080V	1994	0.1	200	20	BLM	13-Aug-96	D	D.J. Roak				
21T01600NR0080V	5RS72	0.1	300	30	CA011	15-Sep-95	D	K.J. Omsberg	F	G	0.05	0.0
21T01600NR0080V	5RS72EB	0.1	250	20	CA011	15-Sep-95	D	K.J. Omsberg	F	G	0.05	0.0
21T01600NR0080V	5RS72NB	0.1	250	20	CA011	15-Sep-95	D	K.J. Omsberg	F	G	0.05	0.0
21T01600NR0080V	5RS72-TIE	0.1	280	20	CA011	15-Sep-95	D	K.J. Omsberg	F	G	0.05	0.0
21T01600NR0080V	A5RS72	0.1	5000	9000	CA011	15-Sep-95	D	K.J. Omsberg	F	G	0.05	0.0
21T01600NR0080V	GOAT-TIE	0.1	100	10	CA011	15-Sep-95	D	K.J. Omsberg	F	G	0.05	0.0

MM 3.05 Display/edit control data in spreadsheet format

High Level Description	
Purpose	To allow for the review of control data in an easily edited format and links to survey points. May optionally input new data.
Actors	Surveyor
Precondition	Need to review or edit control data and links to survey points. Measurement data is displayed graphically so user may select the desired data set to be used. Existing control data is available for the data set to be reviewed or edited.
Postcondition	Control data is presented to user for review and editing. Control data is linked to appropriate survey points.
Description	Allows for the review and editing of existing control data for a selected data set. Optionally allows for input of new control data and links with selected survey points.
Cross reference	Uses: Extends: 3.01, 3.02
Development Implications and Considerations	
Data considerations	
Requirements addressed	

Primary Scenario	
Actor Action	**System Response**
1. Begins when user selects to review/edit the control data.	2. Presents a spreadsheet of the control data of control points within the graphics window. Present option to link control data to survey point data.
3. User selects control points from the graphic display or spreadsheet for the desired control data to review/edit.	4. As user selects control points they are highlighted both graphically and in the spreadsheet.
5. User reviews/edits control data as needed. Editing includes ability to link selected control data to user selected survey points when user marks option for it.	6. Assists user in editing spreadsheet by jumping to next appropriate field as each field is completed. Updates graphics display as changes are made in the spreadsheet. [link control data to survey point data] It automatically creates links or assists user in selecting survey points to link with selected control point(s). Prompt to save changes.
7. User selects appropriate action button.	8. [Save] Saves changes and closes the control data spreadsheet." This is where the native values will be stored and if performance dictates, where the data is stored in the system's datum/projection. **[Cancel]** Exits without saving changes and closes the control data spreadsheet.

Secondary Scenario	
Actor Action	**System Response**
No control data is available.	Warn user and prompt for location of existing control

	data. Presents blank control data spreadsheet when no data is being displayed graphically and user begins use case. Assists user in filling in spreadsheet by jumping to next appropriate field as each field is completed.
Need to link existing control data with existing survey point data.	Presents control data available for data in graphics window. Assist user in selecting survey points to link with a selected control data set.
No existing survey point data is available.	Warn user and prompt for location of survey point data. Assist user in selecting control to link (associate) with a selected survey point.

.

Control Data Spreadsheet

Control Data Worksheet

Control Data												Source Data (3.4)				Merge Control	
								Use Status									
Project	Point ID	Latitude	Longitude	Elevation	N error estimate (ft)	E error estimate (ft)	Datum	Not used in Technical	Not used in Cartographic	NOT Visible	Legal Status	Source Agency Code	Source Id	Published precision	Measurement Agency Code	Township	Point ID
21T01600NR00	140400	391345.6807	1224059.4610	3100	40	40	27					USGS	7.5' Quad	Digitized	BLM		
21T01600NR00	200400	391345.5802	1224024.5592	3100	40	40	27					USGS	7.5' Quad	Digitized	BLM		
21T01600NR00	200500	391438.2746	1224024.8759	3100	40	40	27					USGS	7.5' Quad	Digitized	BLM		
21T01600NR00	200600	391531.4353	1224023.6175	3100	40	40	27					USGS	7.5' Quad	Digitized	BLM		
21T01600NR00	200700	391639.6110	1224027.4385	3100	40	40	27					USGS	7.5' Quad	Digitized	BLM		
21T01600NR00	240500	391438.2168	1223950.1513	3100	40	40	27					USGS	7.5' Quad	Digitized	BLM		
21T01600NR00	300300	391254.4689	1223912.9855	3100	40	40	27					USGS	7.5' Quad	Digitized	BLM		
21T01600NR00	300540	391505.4334	1223916.5778	3100	40	40	27					USGS	7.5' Quad	Digitized	BLM		
21T01600NR00	300600	391531.4218	1223916.6148	3100	40	40	27					USGS	7.5' Quad	Digitized	BLM		
21T01600NR00	400300	391254.8937	1223805.1072	3100	40	40	27					USGS	7.5' Quad	Digitized	BLM		
21T01600NR00	400340	391320.9052	1223805.3303	3100	40	40	27					USGS	7.5' Quad	Digitized	BLM		
21T01600NR00	100700	391632.1340	1224202.2590	3100	1	1	27					BLM	GPS	1st Order	BLM		
21T01600NR00	640700	391639.1800	1223521.9760	3100	1	1	27					BLM	GPS	1st Order	BLM		
21T01600NR00	700100	391123.8855	1223448.5555	3100	57	57	27					USGS	7.5' Quad	Digitized	BLM		
21T01600NR00	700240	391242.6845	1223448.3992	3100	40	40	27					USGS	7.5' Quad	Digitized	BLM		
21T01600NR00	700440	391427.9516	1223448.1151	3100	40	40	27					USGS	7.5' Quad	Digitized	BLM		
21T01600NR00	950009	391251.3021	1223853.0773	3100	10	10	27					USC&GS	Data Sheet	3rd Order	USC&GS		
21T01600NR00	143700	391636.1635	1224114.0686	3100	40	40	27					USGS	7.5' Quad	Digitized	USFS		
21T01600NR00	100600	391530.9097	1224134.3030	3100	40	40	27					USGS	7.5' Quad	Digitized	USFS		
21T01600NR00	100700	391632.3063	1224202.4930	3100	40	40	27					USGS	7.5' Quad	Digitized	USFS		
21T01600NR00	700450	391427.9516	1223448.1151	3100	40	40	27					USGS	7.5' Quad	Digitized	USFS		
21T01600NR00	133100	391127.8423	1224055.9829	3100	283	283	27					USGS	7.5' Quad	Digitized	USFS		
21T01600NR00	700700	391631.7919	1223451.7382	3100	283	283	27					USGS	7.5' Quad	Digitized	USFS		
21T01600NR00	127100				0	0	27					BLM	Merge	None	BLM	21T0150NR001	100700
21T01600NR00	100100	391130.6775	1224758.5418	4000	40	40	27					USGS	7.5' Quad	Digitized	BLM		
21T01600NR00	100200	391157.3874	1224802.4263	4000	40	40	27					USGS	7.5' Quad	Digitized	BLM		
21T01600NR00	100600	391521.3134	1224803.0077	4000	40	40	27					USGS	7.5' Quad	Digitized	BLM		
21T01600NR00	100700	391632.3436	1224846.6375	4000	1	1	27					BLM	GPS	1st Order	BLM		
21T01600NR00	101100	391130.6512	1224757.2762	4000	40	40	27					USGS	7.5' Quad	Digitized	BLM		
21T01600NR00	200100	391130.9843	1224651.6160	4000	40	40	27					USGS	7.5' Quad	Digitized	BLM		
21T01600NR00	200200	391203.8257	1224654.3341	4000	40	40	27					USGS	7.5' Quad	Digitized	BLM		
21T01600NR00	200300	391252.6922	1224655.4195	4000	40	40	27					USGS	7.5' Quad	Digitized	BLM		
21T01600NR00	300100	391129.8659	1224546.4512	4000	40	40	27					USGS	7.5' Quad	Digitized	BLM		
21T01600NR00	300200	391204.5242	1224557.3325	4000	40	40	27					USGS	7.5' Quad	Digitized	BLM		
21T01600NR00	300300	391253.3515	1224557.8369	4000	40	40	27					USGS	7.5' Quad	Digitized	BLM		
21T01600NR00	340600	391521.9676	1224529.1640	4000	40	40	27					USGS	7.5' Quad	Digitized	BLM		
21T01600NR00	400140	391139.8603	1224450.7026	4000	40	40	27					USGS	7.5' Quad	Digitized	BLM		

MM 3.06 Display/Edit Record line data in spreadsheet format

High Level Description	
Purpose	To allow for the review of existing line data in an easily edited format and links to source-level data. May optionally input new data.
Actors	Surveyor
Precondition	Need to review or edit line data and links to source-level data. Measurement data is displayed graphically so user may select the desired data set to be used. Existing line data is available for the data set to be reviewed or edited.
Postcondition	Line data is presented to user for review and editing. Edited data is updated and stored locally.
Description	Allows for the review and editing of existing line data for a selected data set. Optionally allows for input of new line data and linking with source-level data.
Cross reference	Uses: 2.03, 2.04 Extends: 3.03
Development Implications and Considerations	
Data considerations	
Requirements addressed	

Primary Scenario	
Actor Action	**System Response**
1. Begins when user selects to review/edit the line data.	2. Presents a spreadsheet of the line data for all lines displayed within the graphics window. Only full lines being displayed are presented in the spreadsheet. Present option to link line data to source-level data.
3. User selects lines from the graphic display for the desired line data to review/edit.	4. As user selects lines they are highlighted both graphically and in the spreadsheet.
5. User reviews/edits line data as needed. Editing includes ability to link selected line data to source-level data when user marks option for it.	6. Assists user in editing spreadsheet by jumping to next appropriate field as each field is completed. Display lines graphically as they are entered (with reference data for visual validation). Highlight lines according to source-level data. Provide slider bars, drop down lists, and other graphical devices, where appropriate, to minimize blunders and data entry time (defaults and algebraic shortcuts for data values based on previous cell values). Process input on-the-fly and validate data (trap logical errors real time, such as values exceeding specified range; integrate anomaly detection tools). Provide the ability to view and re-order the data in the spreadsheet to assist the discovery of blunders, anomaly patterns, etc. Manage the Point ID numbering scheme (simplest example, automatically increment the point ID numeric value. Support viewing the data in any single unit or in the native units of the entered data (Note: if native units, then color code or have some text tag next to value to indicate its unit)

	[link line data to source-level data] Assist user in selecting source-level data to link with a selected line data set. Prompt to save changes.
7. User selects appropriate action button.	8. **[Save]** Saves changes and closes the line data spreadsheet." This is where the native values will be stored and if performance dictates, where the data is stored in the system's datum/projection. **[Cancel]** Exits without saving changes and closes the line data spreadsheet.

Secondary Scenario	
Actor Action	**System Response**
No line data is available.	Warn user and prompt for location of existing line data. Presents blank line data spreadsheet when no existing data is available or being displayed graphically and user begins use case. Assists user in filling in spreadsheet by jumping to next appropriate field as each field is completed.
Need to link existing source-level data with existing line data.	Presents line data available for source-level data in graphics window. Assist user in selecting source-level data to link with a selected line data set.
No source-level data is available	Warn user and prompt for location of source-level data. Assist user in selecting source-level data to link with a selected line data set.
User selects a sequence of lines and chooses "sum the distances" function.	The distances that are highlighted are added and the sum is displayed to the user.
User selects a line in the spreadsheet and chooses the "mass edit" function.	A form for the distance, quadrant, direction and source ID fields is presented so that when the user fills any of those fields with a value, then that input value overwrites those fields in the highlighted lines.
User selects to display Record Line Data w/ Source Data.	Displays Source Data for each line of Record Line Data in spreadsheet format.

Footnotes:

Real time logic and range validation in scenario #6

- Distances – always positive, except possibly radius distances (curve left) and offset distances (offset to left).

- Quadrants – 1=NE, 2=SE, 3=SW, 4=NW (user enters integer or string, system displays string). I would like to see the "quadrants" field expanded into a "direction reference", to accommodate azimuths. Azimuths could be symbolized with a 0 or space value, signifying "angle Right from North" or "Clockwise from North" and could be displayed with abbreviations like RN or CN. Apparently there are azimuths out there representing angles left (anti-clockwise) from North and angles right from South. I am not sure if they are involved in boundary records, but if they are then this field could handle them.

- Directions – bearing degree <= 90, Minutes and secs < 60, azimuth degrees < 360.

Defaults and algebraic shortcuts in scenario #6:

If user enters “5280 – 20.50” the value to store is 5259.50 and the next default is 20.50.

If user enters “5280 / 8” the value to store is 660 and the next default is 660.

Stationing mode for entry of distances, belongs in scenario #6:

Stationing occurs when distances along a line refer back to the beginning of the line.

Example: Input sequence is 40.3 80.6 81.6 95.7 100.00
Stored values are 40.3 40.3 1.0 14.1 4.3

Stationing continues until there is evidence that a new line has started, as in:
- the direction changes
- a distance value is lower than the previous
- a new “From” point is chosen other than the default
- user indicates that a new line has begun (turn stationing mode off, then on again?)

The order of lines entered into the system has some intelligence to it in helping to locate data and to see patterns of data. The “line numbers” of data in the spreadsheet can be an important tool when redisplaying the data, therefore some way of persisting this data would be very helpful. This numbering may only apply to a particular session or to a particular organization and combining data from various sessions or organizations would fragment the data unless some logic were applied, involving date/time entered and involving proximity.

Record Survey Data Spreadsheet

Record Survey Data (3.6)										
Record Survey Data							Use Status			
Project	From Point Id	To Point Id	Distance	Quad	Bearing	Source Id	NOT used in Technical	NOT used in Cartographic adjustment	NOT Visible	NOT Official Record
21T01600NR0070W	100100	100200	80.000	1	0.0	1880WB				
21T01600NR0070W	100200	100300	80.000	1	0.0	1880WB				
21T01600NR0070W	100300	100340	40.000	1	0.0	1880WB				
21T01600NR0070W	100340	100400	2650.378	1	510.0	5RS72WB				
21T01600NR0070W	100400	100420	1331.830	4	64241.0	5RS72WB				
21T01600NR0070W	100420	100440	1332.490	4	64633.0	5RS72WB				
21T01600NR0070W	100440	100500	40.380	4	64300.0	1986WB				
21T01600NR0070W	100500	100540	40.380	4	64300.0	1986WB				
21T01600NR0070W	100540	100600	2664.898	4	64601.0	5RS72WB				
21T01600NR0070W	100600	100640	40.490	4	14100.0	1987WB				
21T01600NR0070W	100640	100660	29.760	4	305100.0	1987WB				
21T01600NR0070W	100660	100700	30.890	4	305100.0	1987WB				
21T01600NR0070W	200100	200200	80.000	1	0.0	1880				
21T01600NR0070W	200200	200300	80.000	1	0.0	1880				
21T01600NR0070W	200300	200400	80.000	1	0.0	1880				
21T01600NR0070W	200400	200440	40.290	4	2400.0	1986				
21T01600NR0070W	200440	200500	40.290	4	2300.0	1986				
21T01600NR0070W	200500	200540	40.580	1	10500.0	1986				
21T01600NR0070W	200540	200600	40.600	1	13300.0	1986				
21T01600NR0070W	200600	200620	25.330	4	21900.0	1986				
21T01600NR0070W	200620	200630	12.665	4	21900.0	1986				
21T01600NR0070W	200630	200640	12.665	4	22300.0	1986				
21T01600NR0070W	200640	200660	26.120	4	21700.0	1986				

MM 3.07 Export to GMM flat files

High Level Description	
Purpose	Export data for use with GMM. This will allow continued use of existing GMM and CMM software, which will aid in the transition and support of NILS.
Actors	Surveyor
Precondition	Data exists within the NILS database to support the creation of GMM flat files.
Postcondition	GMM data is created for use within GMM.
Description	Export necessary data to GMM flat files.
Cross reference	Uses: Extends:
Development Implications and Considerations	Need the NILS database to support the creation of GMM flat files. Multiple point ids for the same point.
Data considerations	When multiple townships are selected, system needs to know how to parse data into projects by township.
Requirements addressed	

Primary Scenario	
Actor Action	**System Response**
1. Begins when user selects Export to GMM flat file format.	2. The system prompts the user for a location to export the data to, using the township as a project(s) name for default (if applicable).
3. User chooses location for data to be exported to and can modify project name(s) if desired.	4. The system exports the data to GMM flat files by project name.

PM 4.01 Attribute polygons with legal area descriptions

High Level Description	
Purpose	To apply/edit legal area description attributes of the polygons.
Actors	Parcel Editor, Surveyor
Precondition	1) Polygons/parcel fabric exists 2) The polygons need to be attributed or the legal area description attributes exist, and need to be updated.
Postcondition	The polygons are attributed correctly with legal area descriptions.
Description	Polygons need to be correctly attributed with their legal area descriptions.
Cross reference	Uses: 4.2 Extends: 4.2, 4.3
Development Implications and Considerations	
Data considerations	Uses LLD attributes from LR2000. Massive data conversion of existing GCDB data? Uses existing parcel coverage data. Database access rights. Does all this occur locally, or is it in the database?
Requirements addressed	

Primary Scenario	
Actor Action	**System Response**
1) Begins when the user selects edit Legal Area Description Attributes.	2) Highlights selected polygons and displays a form to edit the legal area description. The form shows the value for legal area description. Polygons with NULL values are symbolized differently on the graphics display. If the system unexpectedly displays NULL values, go to Secondary Scenario.
3) User edits the legal area description update form.	4) The system assists the user in updating the legal area description. System prompts to save data.
5) User selects the appropriate action button.	6) [SAVE] Saves changes. [CANCEL] Exits without saving data.

Secondary Scenario	
Actor Action	**System Response**
There is no existing legal area description data and there should be.	The system assists user in finding existing legal area descriptions e.g. [BROWSE]. Once found, the system loads the legal area description, and creates the link. The system then goes to step 2.

Footnotes:

This use case omitted the stage where the system automatically attributes the polygons based on the relationship the polygon has with the point IDs that define its boundaries. In GMM this is initially accomplished with the program LLDW.EXE, with some help from the program RPOLYW.EXE. These programs work from the intelligence of the point ID scheme. Values from 100100 to 711700 describe a

point's location and function within the PLSS Township. Values above that, up to 950000 describe generally what kind of special survey created the point.

Also, when small aspects of topology change, such as additional points added to a polygon's perimeter, the system should still be able to identify each polygon. When a new line divides a known polygon into two pieces, there must be a way to assist the user in specifying what that line represents. (Does the old polygon retire with an ending date to be replaced by two new polygons with new starting dates, for instance?)

We need a spreadsheet window to be an input device that is integrated with the spatial display.

Legal Area Description Spreadsheet

Legal Area Descriptions (4.1)													
State	Mer	Tier	Range	Dup	Sec	Nominal	Type	Number	Suffix	Note	Acreage	Exception	Conflict
az	14	32 N	16 W		33	A	L	1			37.145		
az	14	32 N	16 W		33	B	L	2			37.152		
az	14	32 N	16 W		33	E	L	3			37.159		
az	14	32 N	16 W		33	F	L	4			37.166		
az	14	32 N	16 W		33	C	A				40.000		
az	14	32 N	16 W		33	D	A				40.000		
az	14	32 N	16 W		33	G	A				40.000		
az	14	32 N	16 W		33	H	A				40.000		
az	14	32 N	16 W		33	J	M	1379			20.661		
az	14	32 N	16 W		33	J	L	8			8.712		
az	14	32 N	16 W		33	KV	A				20.000		
az	14	32 N	16 W		33	KW	A				20.000		

PM 4.02 Display polygons with symbology by legal area description types

High Level Description	
Purpose	Provide users with a visual aid in identifying legal area description types.
Actors	Parcel Editors, Surveyor
Precondition	Parcel fabric is displayed on screen. Polygons need to have the legal area description attribute field.
Postcondition	Polygons are symbolized with the legal area description.
Description	Polygons are symbolized according to their legal area description. NULL values are included in the symbology.
Cross reference	Uses: Extends: 4.1
Development Implications and Considerations	Need to meet ADA requirements for symbols and colors.
Data considerations	Uses LLD attributes from LR2000. Massive data conversion of existing GCDB data? Uses existing parcel coverage data. Database access rights.
Requirements addressed	

Primary Scenario	
Actor Action	**System Response**
1) Begins when the user selects to display Legal Area Description Attributes.	2) System will load user defined symbology template and display polygon symbology accordingly.

Secondary Scenario	
Actor Action	**System Response**
The user wishes to change symbology template or create a new template.	The system displays the symbology manager window allowing the user to change templates and create new ones.

PM 4.03 Label polygons with attribute data

High Level Description	
Purpose	Provide users with a visual aid in identifying legal area description types by labeling polygons.
Actors	Parcel Editors, Surveyor
Precondition	Parcel fabric is displayed on screen. Polygons need to have the legal area description attribute field.
Postcondition	Polygons are labeled with the legal area description.
Description	Polygons are labeled according to their legal area description. NULL values are also labeled.
Cross reference	Uses: Extends: 4.2
Development Implications and Considerations	
Data considerations	Uses LLD attributes from LR2000. Massive data conversion of existing GCDB data? Uses existing parcel coverage data. Database access rights.
Requirements addressed	

Primary Scenario	
Actor Action	**System Response**
1) Begins when the user selects label Legal Area Description Attributes.	2) System will load the user defined or default template and labels the polygons accordingly.

Secondary Scenario	
Actor Action	**System Response**
The user wishes to change label styles within the style template or create a new template.	The system displays the symbology manager window allowing the user to change templates and create new ones.